[ESTABLISHED 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE, INC.
140 NASSAU STREET, NEW YORK

J. S. BONSALL, Vice-President and General Manager

Editors:
E. A. AVERILL. R. H. ROGERS

V. C. JONES, Western Representative
407 Medinah Bldg., Chicago

NOVEMBER, 1911

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CONTENTS

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THE BRICK ARCH

Users of the brick arch five to ten years ago can be divided into two classes, those who found sufficient advantages in it to more than equal the expense of the brick and trouble of maintaining them, and those who found their conditions such as to make the arch unprofitable. Both classes have much to learn concerning the brick arch as it is now being designed. The sectional arch now being generally applied is much different from the old-style design and eliminates all of the principal objections previously raised, permitting the advantages to be obtained under nearly all conditions without the offsetting disadvantages and unwarranted expense.

Carefully conducted tests on all sides indicate the arch to be one of the most valuable fuel economizers or capacity increasers. As reported in another part of this issue, the tests on the New York Central Mallets show that in connection with the superheater, the arch alone gave a fuel saving of about 11 per cent. As we begin to approach the limit of the fireman's endurance an opportunity for an 11 per cent. saving in fuel, or, in other words, a 13 or 14 per cent. increase in capacity of locomotive is of inestimable value.

It is interesting to investigate the effect of the arch in the firebox which causes such a difference in the boiler capacity as a whole. The arch as now generally installed is carried on water tubes, from two to four in number, depending upon the width of firebox, extending from the inside throat sheet to the upper part of the back firebox sheet. The arch brick in small sections, each of them of a size to be conveniently handled by one man, rest on and between these tubes and are carried upward to a point about 18 to 24 inches from the crown sheet, extending back from ½ to ⅔ of the length of the firebox. They are sometimes tight against the throat sheet, but more often a space of 3 or 4 inches is left open at this point.

In a firebox without a brick arch, when the door is closed, the flame and gases from the fuel bed probably take an almost direct path to the tubes, in which case the back firebox sheet or door sheet, a large part of the crown sheet and the upper back corners of the side sheet have no direct impinging action from the flame and receive only radiated heat. While no one yet has accurately determined what the relative value of firebox and tube heating surface may be, there is do doubt but what firebox heating surface is several times as valuable as an equal amount in tubes, and in a locomotive without a brick arch fully half of this surface is not utilized to the best advantage.

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sheet, the crown sheet and the back part of the side sheets, permitting them to transmit as much heat as the water circulation back of them will absorb. At the same time, the section in front and above the arch are not robbed of their opportunity.

There is another feature in connection with the brick arch which seems to explain part of the result, and that is in getting and holding very high temperatures along the bottom of the side sheets. The amount of heat passing through a steel plate is to some extent governed by the same rules as the amount of water passing through a pipe, *i. e.*, the difference in temperature between the two sides of the sheet act much the same as the difference in pressure at the two ends of a pipe. With the arch the high temperature held along the bottom of the side sheet where there is the lowest temperature on the opposit side gives an opportunity for this surface to transmit its maximum capacity.

While a fair proportion of the value of the arch is probably due to the presence of an incandescent body in the midst of the firebox and the increasing of the length of the flame, it would appear from the discussion just given, that its action simply as a baffle plate is one of its most important features.

BLOCKING THE INITIATIVE

A prominent feature of railroading as viewed in this country of late is the widespread policy of encouraging the rank and file to take the initiative, possibly not so much in action, but in suggestion. It is not at all uncommon to see boxes placed close to master mechanics' offices where the men are requested to deposit any idea, plan of work or appliance which may be in the direction of improving existing conditions or methods. In consequence of this obviously correct procedure, thousands of ideas have been worked into practical possibilities of incalculable value to the general scheme of locomotive maintenance.

It is rather expected, indeed, from an American standpoint, that mechanics shall be originators of ideas, and it is quite evident that of late they have measured up to it. In fact, it may be said that many of the advanced ideas which prevail to-day originated at the bench or the machine, and railway management sensibly fosters this inventiveness.

In contrasting shop methods abroad with those prevailing in this country it is impossible not to be impressed by the fact that very little initiative seems to be permitted or taken advantage of by either shopmen or their foremen. This is particularly noticeable in the lack of the commonest labor-saving devices, and what have been termed on this side of late "shop kinks," are practically unknown quantities. An observer will search in vain for the examples of inventive ingenuity which practically every American shop can afford in profusion, and which in many instances have so greatly simplified and cheapened production as to be unbelievable.

A very interesting study is afforded in this contrast and it will be found as it progresses that the problem is not by any means unsolvable. In the long run it simply resolves to the fact that in this country the workman is given every encouragement to think, from the time when he enters on his trade as apprentice until the highest pinnacle has been reached, while abroad he is encouraged not to think, the latter being largely the perquisite of the directing heads.

This impression was formed after a very long and close analysis of foreign shopmen and methods, and even of the train service. Every move is laid out in advance, so far as any possible contingency can be estimated, both in the shop and on the road, and this detail is indeed carried to such a refinement that it would appear the man who does the thinking would not only consider any omission a very serious matter, but a personal reflection as well.

In keeping with this condition it is not surprising that the men in the large repair shops appear to be a very comfortable lot. They take life easily and impress the visitor as not intending to work too hard. Certainly they do not appear as a body who would remain up nights endeavoring to evolve new jigs and methods. Should they attempt the latter it is not at all likely that the suggestion would be viewed with any particular favor, even if they could be placed before the head, who, by the way, is very much further removed from his rank and file than any superintendent of motive power under our plan of organization.

So long as this heavy thinking is done by very few men they are enormously compensated. F. M. Webb, chief mechanical engineer of the London and North Western Ry. of England, received the equivalent of $35,000 per year. They are willing to pay a man well who can think for his entire department. It is said that Mr. Webb discouraged his men to produce labor-saving devices because he had an ample staff of mechanical engineers for that purpose and who were well paid to do all of the inventing. Thus the range for originality became somewhat constructed on that system at least.

It is practically unknown for a subordinate official, even, not to mention the vast rank and file, to take the initiative. The features of personality and individuality which endow American railroading with such a valuable as well as picturesque aspect are entirely lacking abroad, because the employees, through the absolutely inflexible system of organization which prevails, must be largely automatons. The general scheme is also a wonderful example of absolute subordination, one so complete that individual effort is seriously hindered, if not altogether checked. The men are inherently not self-assertive, as in this country, and in the face of the prevailing systems this cannot well be engendered.

RAILROAD SHOP TOOLS

It is a singuar fact in connection with American railway methods that the majority of roads do not seemingly favor the existence of a depreciation fund for taking care of shop machinery, and so far as regards this particular item, at least, something of value might be learned from an analysis of methods in vogue overseas, and especially in England. The system there adhered to makes admirable provision for the maintenance of not only rolling stock, but machine tools as well by setting aside annually a definite amount to be spent for this work. This amount is increased from time to time with the increase in the amount and capacity of the equipment, and it forms an adequate depreciation fund for keeping the rolling stock and shop equipment up to a uniform condition of efficiency.

Five per cent. is taken as a fair amount to be allowed for depreciation on each machine tool per year, and it is claimed that an annual appropriation of 5 per cent. of the value of the machinery in each shop would practically renew the machine equipment once in every 20 years. This must naturally appeal as a far more sensible and consistent procedure than that generaly prevailing where a master mechanic must make a desperate fight for many months before a machine admittedly obsolete can be replaced by one of modern design capable of returning adequate service for the investment.

In this general connection many timely inferences may be drawn of much significance. For instance, in buying new machines care should be taken to select those which will effect the largest earnings. Needless to add that care should also be exercised to see that the machines which are known to be the least profitable should be first replaced by those of modern design. Special machines, excepting wheel and axle lathes, which are as a rule essential, are generally unprofitable except in cases where they can be kept in constant use.

The selection of lathes, for example, is a matter requiring care and deliberation. In many cases it would be preferable to decide on a turret lathe instead of an engine lathe, as on certain classes of work a modern turret lathe will produce from two to five times as much work as an ordinary engine lathe. Another machine which is superior in many instances to the latter is the vertical boring and turret mill or lathe. This machine will produce at least double the amount of work that is possible on an engine lathe; almost anything that an ordinary lathe can do, and

much that it cannot perform, is handled hereon usually in a much shorter time, and in a more satisfactory manner, with the additional advantage of occupying less floor space.

A well-equipped tool room has more to do with the efficiency of a shop than the majority of master mechanics seem to realize. Every tool should have its place and should be kept in good condition for immediate use so that when it is needed it can be procured quickly. Old machine tools should be replaced by modern tools as quickly as possible, for until they are the railroad shop will not be in proper position to reap the full benefits to be derived from high speed steels and up-to-date methods.

QUICK RETURN CRANK SHAPER MOTION

TO THE EDITOR:

We refer to your article on page 416, October, 1911, issue, about the quick-return motion of the crank shaper. We use the simple form of quick-return mechanism, and we ask for space to show why we believe this is the best, mainly because it is simple, and why the mechanism described as the two-piece crank is objectional from reverse reasoning, because it is very complicated. We merely wish to show the mechanism of both types so that the railroad mechanical departments can judge between them.

In Fig. 1 herewith is shown the construction of our simple quick-return mechanism. It will be noted that there is but one bearing surface to this bull gear, as compared to ten bearing surfaces in the complicated quick-return mechanism. A little further along we will show these ten bearing surfaces. The one bearing surface of the simple quick-return mechanism is the hub of the bull gear in the column. Be sure to note that this journal is hardened and ground, and has a self oiling bearing. This hardened and ground journal with flooded lubrication will not wear elliptical. It will also be noted that the gear teeth are radial from a point within the bearing to reduce the overhang all that is possible, and that the hub is very long to offset the overhang.

In Fig. 2 we show the four parts of the so called two-piece-crank, obtained by separating the component parts of this bull gear. The ten bearing surfaces, all of which are in action while the tool is cutting, are as follows: Number 1 runs in column and corresponds to the one hub bearing of the simple quick-return mechanism; but although this bearing must take the full thrust of the cut it is very short as compared to the same bearing in the simple quick-return. The other bearing surfaces are numbered so that the journal and its bearing can be easily seen, the journals being indicated by numbers 2, 3, 4, etc., and the corresponding bearing by numbers 2′, 3′, 4′, etc. Number ten is in contact with a flange on the column.

Is it necessary to point out that these nine extra bearing sur-

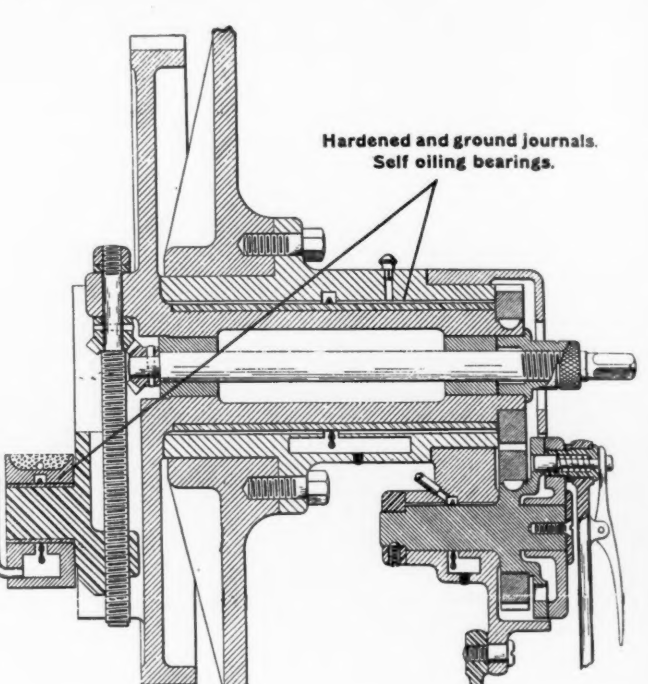


FIG. 1.

faces are increasing friction and wear? It should also be noted that two of these bearings are flat rubbing surfaces (No. 7 and No. 8) acting like a brake, and some of the radial moving parts are placed close to the periphery of the bull gear (No. 4, No. 9 and No. 10) which is more objectionable from a standpoint of frictional increase than a well designed hub bearing. We wish to say right here, that the designing of machine tools is going rapidly away from the complicated to the simple forms of mechanism, and the designer who can get the same action with fewer parts is the most successful.

We freely admit that the complicated quick-return mechanism shown does bring about the effect desired by its designer, that of a very quick-return and an even cutting speed, but at what a loss of simplicity and power! Power of efficiency is our pet hobby, and we court investigation and tests to demonstrate our position in this respect. Is an even cutting speed so desirable in planing? If so, why is Mr. Powell so enthusiastic over his accelerating cut planer? Further, it has been shown time and again, that the quick-return in planing is not nearly so important as the speed at which the cut can be taken. If the quick-return is so important, why the variable speed planer with a constant return? The accelerating motion of a shaper ram is especially valuable in that it reduces the shock of the tool's entering and leaving the work. A heavier cut can be taken, and a faster speed maintained. In other words, more work and better work with less expenditure of power.

QUEEN CITY MACHINE TOOL CO.,
Cincinnati, O.

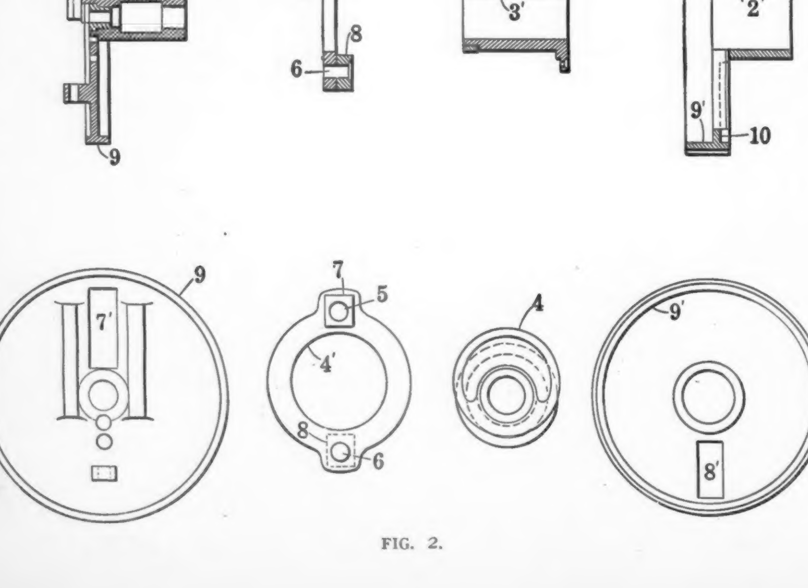
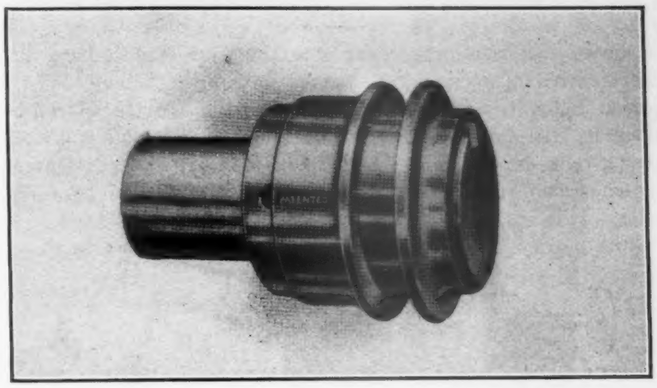


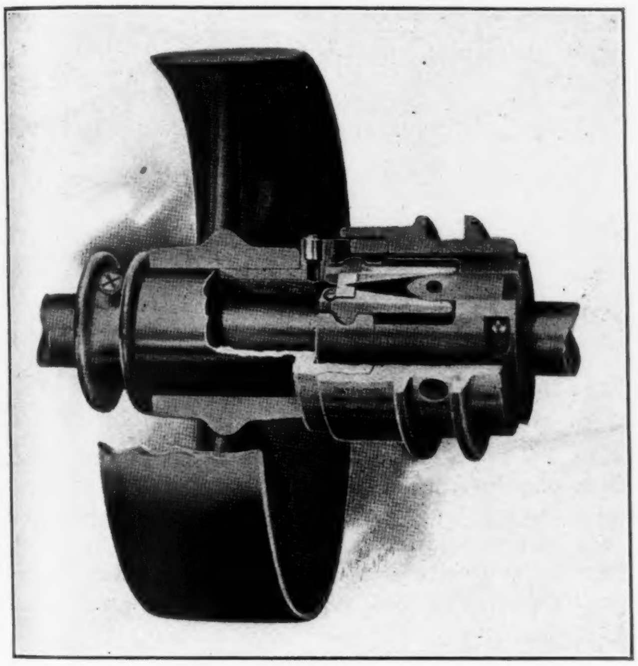
FIG. 2.

IMPROVEMENTS IN SPEED CLUTCHES

The advent of high speed steels, demanding better and more powerful clutches on countershafts, and many other requirements imposed by modern practice, has resulted in a very high development of these devices. They have been adopted for use as parts of machines by some of the leading manufacturers with perfect success. For the past several years the Carlyle Johnson Machine Co., of Manchester, Conn., makers of the Johnson friction clutch, have been embodying many improvements which simplify the working mechanism of these clutches, and add to their efficiency, with the result that a product is attained in the new design leaving practically nothing to be desired from the viewpoint of either efficiency or simplicity.



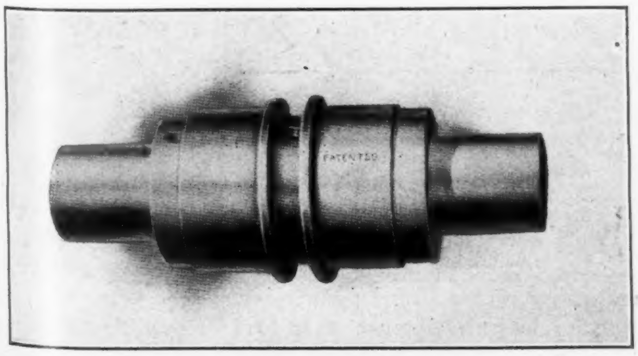
SINGLE CLUTCH—EXTERIOR.



SECTION SHOWING CLUTCH ENGAGED AND PULLEY MOUNTED ON HUB OF FRICTION CUP.

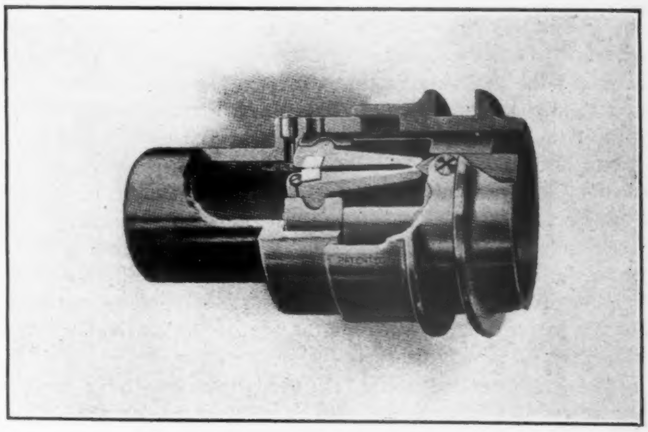
As will be seen in the accompanying illustrations, this clutch has but few parts, and is very compact. A body fastened to the shaft carries a split ring in which are inserted a pair of levers. A curve-shaped wedge, which is made part of a shipper sleeve, forces the levers apart, expands the ring and brings the outer surface into frictional contact with the inner surface of the friction cup, the hub of the latter being made to suit requirements.

The leverage is so compounded that very little pressure is required to operate the clutch. One screw which moves two taper blocks, set into the levers, adjusts the contact of the ring and cup to any tension. This is easily reached with a screw driver through a hole in the friction cup. The perfectly smooth shipper sleeve entirely covers the working parts so no dirt can get near them. The double clutch requires but little more space than single and has two friction cups with hubs on which can be mounted pulleys, cones, gears, etc., of any diameter and face.



DOUBLE CLUTCH—EXTERIOR.

The double clutch has been employed with great success in the instance of some of the largest machine tools ever constructed, a notable illustration being in connection with the Betts' heavy boring and turning mill. One of these machines swings 20 ft. 3 in. in diameter and takes work 12 ft. high under the tools. The tool spindles have a travel of 72 inches, and the total weight of the machine is 373,000 lbs. In this very massive design ease of operation has been very largely secured through liberal use of the friction clutches above described. Two double clutches are used in the nest of gears on either side of the machine, the design being such that the face plate or table, instead of being driven by one pinion, is driven by two pinions, one on each side. The feature of driving from both sides of the table tends toward smooth running and increased stiffness under cuts that are not entirely continuous. The Newton 30 in. horizontal milling machine and the Newton I-beam, cold saw cutting off machine afford additional instances of how this small compact clutch is used by machine tool builders as part of some of the best high grade machine tools built. It is said that 16,000 of these clutches have been used by one manufacturer of turret lathes as part of the lathe head.

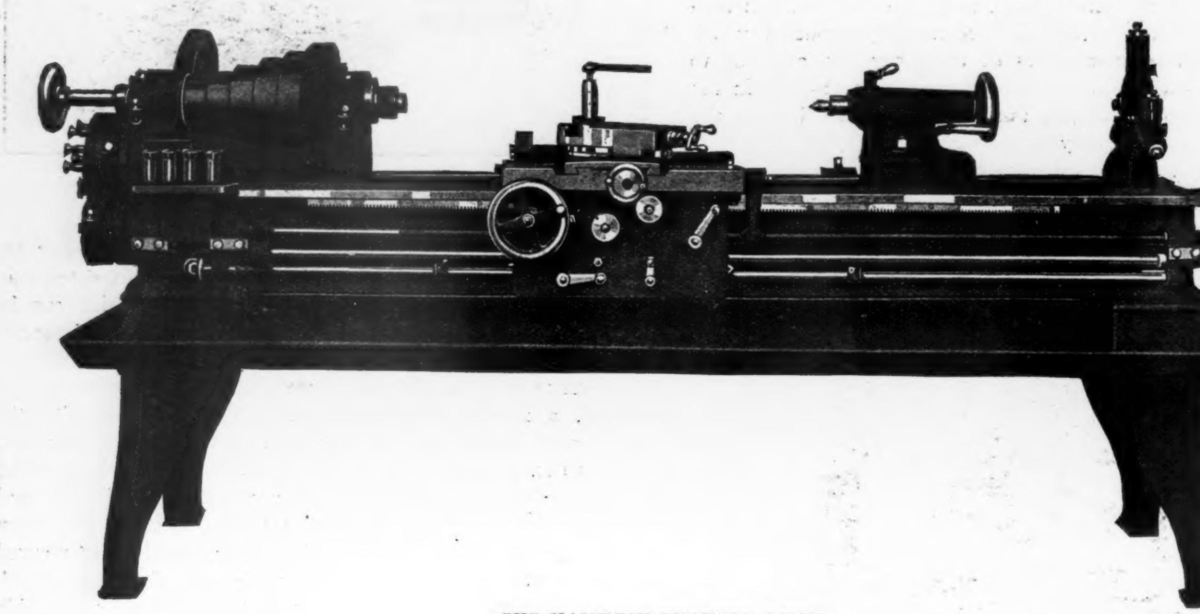


SECTION SHOWING CLUTCH DISENGAGED.

The method of driving machinery direct from the line shaft by the employment of this device, without the use of countershafts over each machine, is also of decided interest. The saving in power, pulleys, countershafts, overhead or across belts, the maintenance of which is a constant item of expense and amounts to considerable each year, soon pays for this equipment. This form of direct drive is now being extensively used by many large manufacturing concerns throughout the country with entire satisfaction. The amount of friction eliminated and the power saved by such a drive can no doubt be readily appreciated.

A REMARKABLE NEW RELIEVING LATHE

One of the most progressive steps in lathe manufacture that has occurred in many years is noted in the new "Hamilton" relieving lathe, which is the latest production of the Hamilton Machine Tool Co., of Hamilton, O. This new machine is a lathe with a relieving device for backing off straight or taper taps or reamers, also for both straight, angular and face mills. The novelty of this construction is that it will not only do the work of any lathe, but will do the work of any relieving machine as well.



THE HAMILTON RELIEVING LATHE.

The attempt has been made in the past to provide this dual capacity through relieving attachments, but these cannot be likened to other than makeshifts, as through their use only straight work is possible, whereas in the machine under consideration taper, angular and face work can be performed with equal facility. This relieving device is not an attachment in any sense, but is built into and is a part of the lathe itself. At the same time the interchange of a long screw for a short one throws out the relieving feature of the machine and converts it into a standard lathe. The new machine will relieve all straight and taper tap and reamers, also all straight and angular face mills up to 10 in. in diameter, with any number of teeth from two to sixteen. It is not confined to outside relieving, but will do inside work as well, such as hollow mills, doing it as rapidly and as accurately as a machine built solely for that purpose.

An analysis of the relieving device becomes naturally the most interesting feature in the study of this fine tool, and through reference to the line drawing of the top of the carriage its operation may be readily grasped.

In this *a* is a coiled spring adjusted by means of a screwdriver screw and is provided with a lock nut, which should be kept tight so as to maintain an even pressure of the cam link *c* against the cam *b*. Of the latter three are furnished, one double, one triple, and one quadruple, which are sufficient for relieving sixteen numbers of teeth, from 2 to 16 inclusive. This cam is easily removed after releasing the tension of spring *a*, and it is held in place by a screw and washer. *c* is the cam link which is held against the cam *b* by means of spring *a*, and must be removed before trying to lift out cam *b*.

The adjusting block, which gives any amount of relief from 1/32 in. to 5/16 in. is marked *d*, and is operated by the adjusting screw *e*. This is a double screw, one inside of the other, and by loosening the outer screw and turning the inner screw, either to the right or left, the amount of relief is increased or diminished as required. *f* is the adjusting gear and is used for setting the work in proper relation to the tool so that the same will "kick back" at the proper time. This is a very handy feature, as by loosening the two bolts the spindle can be turned by hand without changing the position of the cam. *g* is a short screw, and when the lathe is not required for relieving should be removed and the long screw which is furnished put in its place. This substitution converts the machine into a standard lathe.

The new lathe will handle work up to its greatest capacity between centers, the relieving mechanism being driven from the back gearing through change gears and a splined rod which extends the full length of the bed. The shaft drives a spur gear, which in turn drives another spur gear running loose on a slotted disc which is keyed to a bevel gear shaft. Changing the throw to suit any particular work is accomplished by turning a screw on the outside of the swivel. This regulates the position of the adjusting block that slides along the cam link inside of the swivel and connects with the cam. The swivel itself, turning easily on its center post, enables the tool to be brought up to the work from any position desired. The compound rest tool slide is held up against the cam by a heavy adjustable spiral spring, which assures positive action and reduces the possibility of looseness through wear to a minimum. All shafts on the carriage run in hardened and ground bearings and are provided with hardened and ground thrust washers.

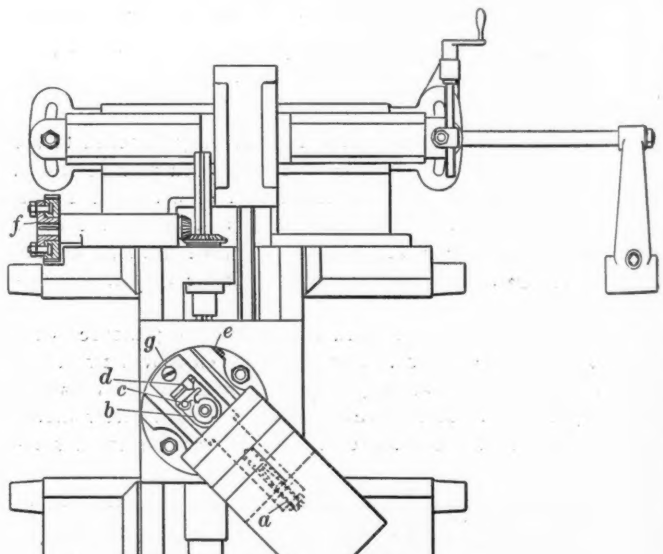


DIAGRAM OF RELIEVING DEVICE.

THOMSEN AND ELNSER LOCOMOTIVE SUPERHEATER

An occasional objection has been raised in connection with the ordinary form of high degree superheater on the grounds that through the necessary employment of quite a number of large flues to contain the superheater elements there is a very large diminution of the evaporative surface of the boiler. Notwithstanding the fact that this view may be considered as based on theoretical assumption more than on the fact of reduced efficiency an experiment is now under way with the end in view to apply the superheater to tubes of the ordinary diameter. With this end in view Thomsen and Elnser, on the staff of the Schmidt Superheater Co., have been granted patents in Cassel, Germany, on an entirely new arrangement which may be applied without any interference with existing boiler conditions, provided that the flues are of 2¼ in. diameter, or at least above two inches in diameter.

One of the fundamentals in superheater design up to a comparatively recent period was to provide a superheater on each side of the boiler, and to allow each superheater to supply steam to the cylinder on one side of the locomotive only. It has been advanced, in this connection, that this construction makes it often difficult to obtain a sufficient quantity of highly superheated steam for each cylinder. On the other hand, as the steam is only drawn from each superheater twice per revolution of the engine the claim is also advanced that the superheaters are not worked to their full capacity.

In the arrangement herein illustrated, in which interest centers principally is the fact that extra large flues are not a requisite, it will be also noted that provision is made for a superheater with its headers opening into a common duct which supplies steam to the cylinders. These headers or collectors supplying the superheated steam are individually in communication with separate cylinders, the collectors being interconnected in such a manner that all co-operate in supplying steam to the engine irrespective of the outlet from which it is withdrawn.

Fig. 1 is a longitudinal section through part of a locomotive boiler fitted with the superheater. Fig. 2 is a section on the line 2 of Fig. 1, looking from the right-hand side, and Fig. 3 is a section on the line 3 of Fig. 1, looking from above. The superheaters are arranged with tubes (*A*) situated within the smoke tubes (*B*) of the locomotive. The superheater tubes (*A*) are connected at their ends to headers (*C*) and (*D*), the headers (*C*) being provided with a connection (*E*) to the steam space of the boiler. The superheater tubes (*A*) are disposed as shown, and are connected to their headers by bridge pieces (*F*) bearing upon flanges (*G*) formed on the superheater tubes and secured to the header by means of the bolts (*H*). The headers or collectors (*D*) are connected by pipes (*S*) to the cylinders of the engine, and are also interconnected at their upper ends by the pipe (*J*).

By means of this arrangement the claim is advanced that from whichever outlet the steam is withdrawn the whole superheater plant is operative in supplying steam to the outlet, so that an ample supply of superheated steam is provided and the superheaters are worked at their full capacity. The design is not restricted to locomotives, as it may be equally well applied to other plants, in which a plurality of superheaters are used, to supply superheated steam to the cylinders of a multi-cylinder engine.

FIG. 2

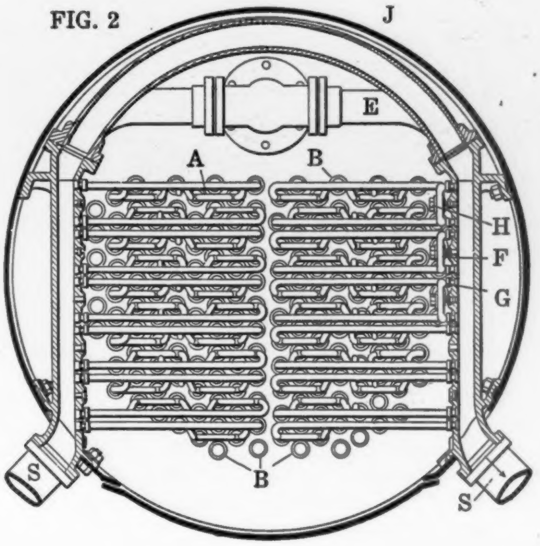


FIG. 1

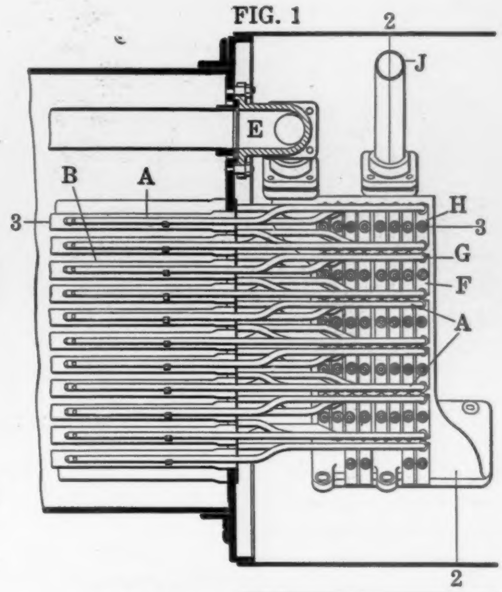
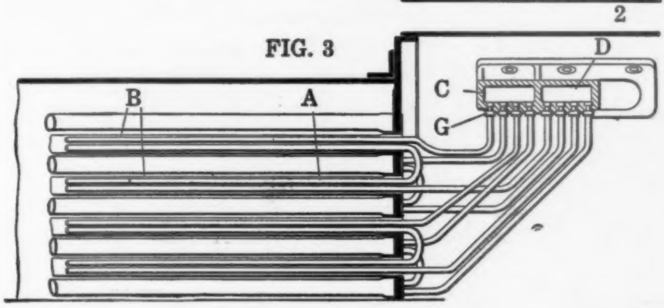


FIG. 3



APPLICATION OF SUPERHEATER TO ALL BOILER TUBES.

THERE ARE IN THE WORLD TO-DAY about 1,300 miles of railroads upon which electricity is used for heavy service. Far the greater part of this mileage is in the United States. In addition there are 435 miles of electric elevated and subway lines in the cities of Boston, Chicago, Philadelphia and New York.

WITH THE USE OF PETROLEUM by the transportation and manufacturing industries, California has practically done away with coal as a steam-raising fuel. Oil is also used in that State in making gas employed for cooking, heating and lighting.

ELECTRIC LOCOMOTIVES IN THE HOOSAC TUNNEL

BOSTON & MAINE R. R.

In the newly electrified Hoosac Tunnel, the Boston & Maine Railroad Company has in service five electric locomotives for hauling the trains and their steam locomotives with banked fires through the tunnel. This practically eliminates the obnoxious steam, smoke and gases incidental to steam operation. These locomotives have four geared motors, twelve wheels, and are designed for operation on 11,000 volts alternating current. Two are used for heavy freight service and the remaining three for combination passenger and light freight service.

The electrified zone extends from Hoosac Tunnel Station, Mass., to North Adams, Mass., a distance of 7.92 miles, of which 4.75 miles are within the tunnel. The central zone of the tunnel has an almost level track 1,200 feet in length, with an ascending 0.5 per cent. grade up to this level track from both the east and west portals.

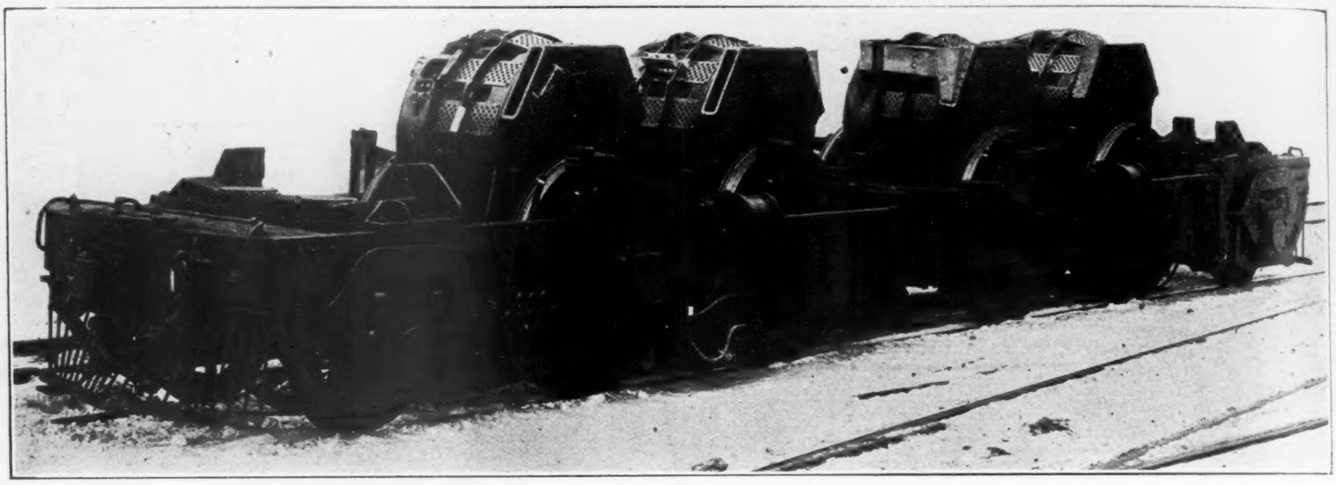
For passenger service, the locomotives were designed to handle trains having a maximum weight of 730 tons, inclusive of steam and electric locomotives, and to maintain a schedule time of 14 minutes between East Portal, Mass., and North Adams, Mass. The locomotives for freight service were built to handle heavy freight trains having a maximum weight of 2,000 tons, including both steam and electric locomotives, and are required to accelerate this tonnage on the 0.5 per cent. grade in the tunnel.

These locomotives are similar in every way to those built a little over a year ago for the New York, New Haven & Hartford Railroad, which were illustrated on page 245 of the June, 1910, issue of this journal. They incorporate a running gear consisting of two separate trucks, each having two pairs of 63 inch drivers and a radial pony truck. The motors are mounted on the truck frame over each driving axle and drive through gearing. The truck side frames follow the general design of the cast steel frames for steam locomotives, except that they are outside of the wheels. The side frames are joined at each end by a cast steel box section girder of sufficient strength to care for the stresses involved in bumping in freight service. The bumper girder at each end of the locomotive is equipped with an M. C. B. coupler mounted with a Westinghouse friction draft gear.

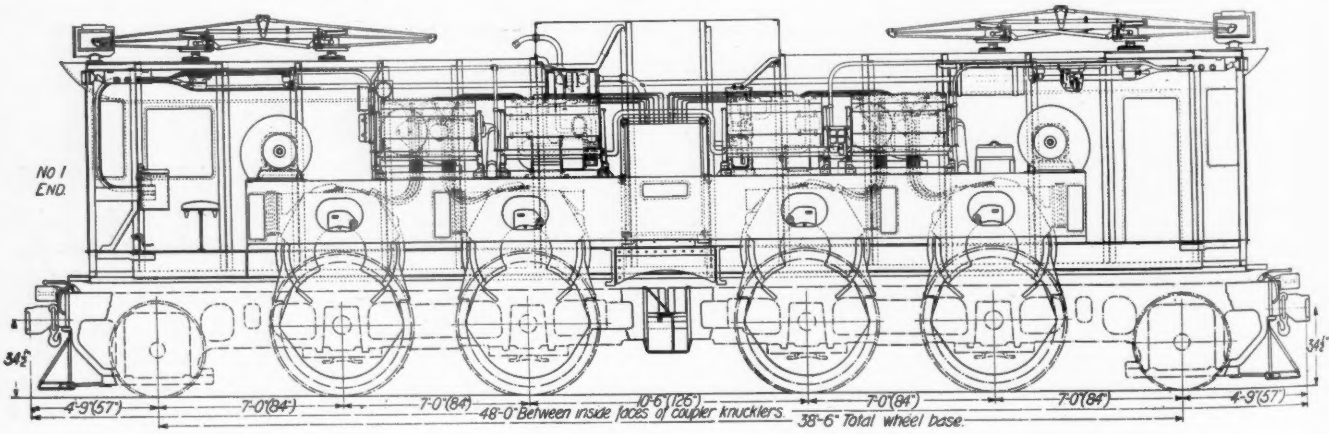
The adjacent bumper girders at the midlength of the locomotive are joined by a drawbar with a pin connection at each end. The eye in this bar is elongated at one end and the length of the bar is so arranged that it is impossible for the bar to be subjected to compression under severe bumping conditions. The three wheels on each side of each truck are equalized together. The longitudinal stability of the trucks is provided by the method of mounting the cab which is supported by eight spring-loaded friction plates, two plates resting on each end of the truck. This relieves the truck center pins of all the weight. This method of supporting the cab interposes two sets of springs in series between the rail and the cab and gives an exceptionally easy riding cab. To relieve the cab from possible pulling and bumping strains, the center pin of one truck is arranged with longitudinal clearance. This truck can not only rotate, but can also move longitudinally relative to the cab.

In the interior of the cab a long raised deck is built along the center line which covers the motors and serves as a stand upon which the control apparatus is erected. The central arrangement of the equipment, with the numerous side windows, affords excellent light and ample room for inspection and overhauling.

Each motor is bolted rigidly to the truck frames and each is so arranged that they can be lifted by a crane after the cab has been removed, or they can be taken out through a driver drop pit. The procedure in such a case requires first the dropping



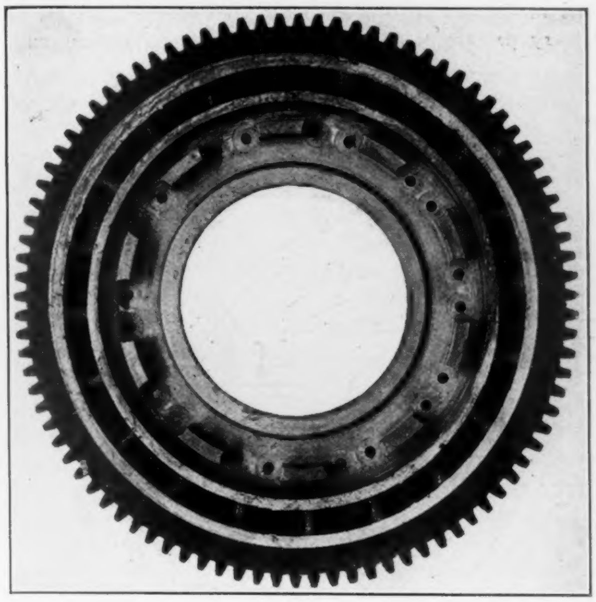
ARTICULATED ELECTRIC LOCOMOTIVE WITH CAB REMOVED.

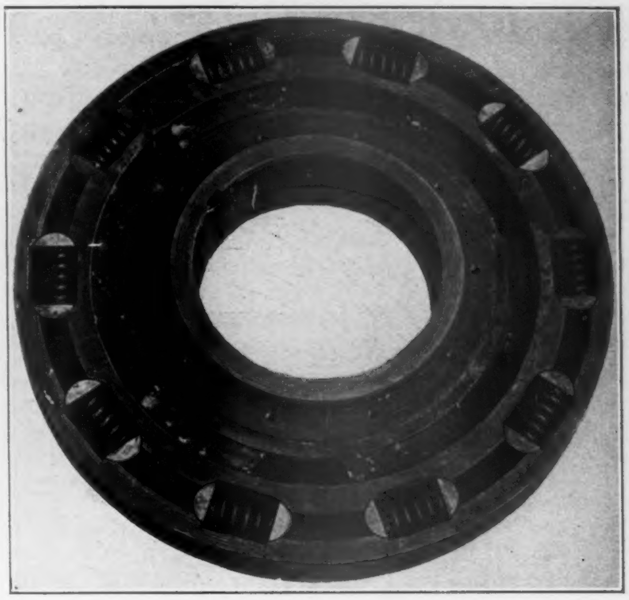


ELEVATION OF B. & M. ELECTRIC LOCOMOTIVE, SHOWING GENERAL ARRANGEMENT.

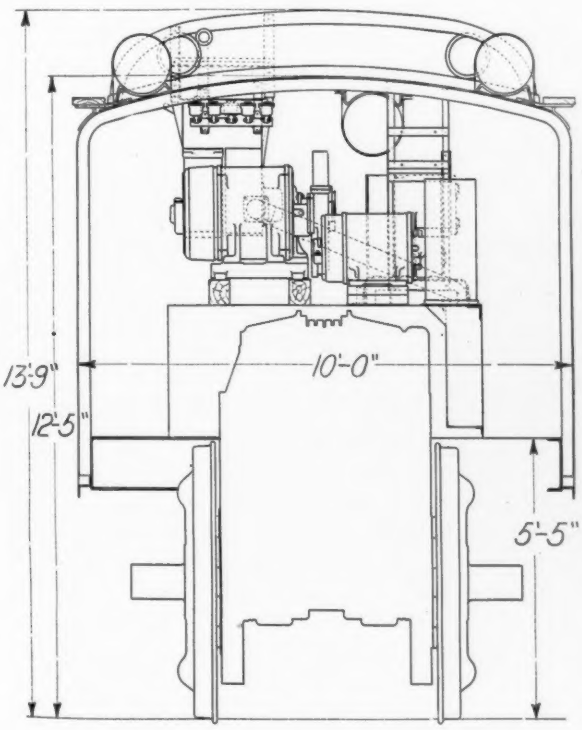
of the drivers with its quill and their removal. The drop pit jack is then placed under the motor and lifts its weight off from the frame. The construction is such that the motor feet rest on the truck frame through bridge blocks, thus after the weight is carried by the jack, these can be removed and the motor dropped directly into the pit.

This method of mounting the motors gives the highest center of gravity possible with the motor connected to the axle by a single reduction gearing.



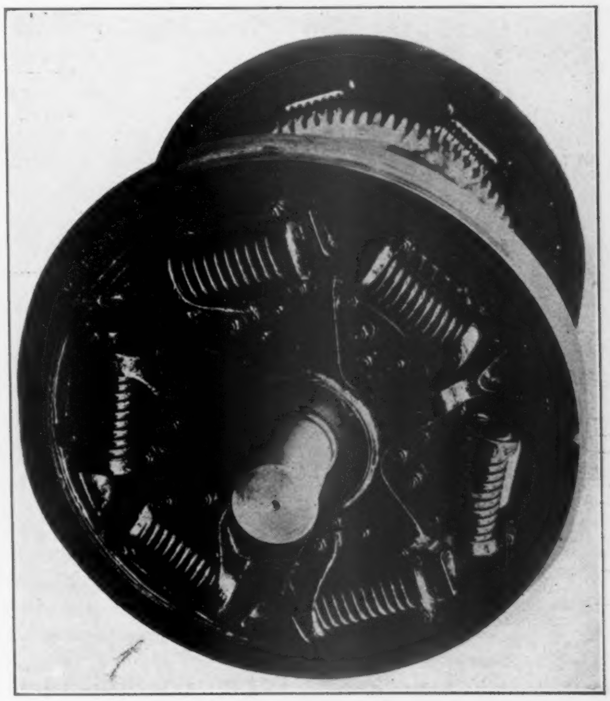


GEAR RIM AND CENTER, SHOWING FLEXIBLE DRIVE BETWEEN MOTOR PINIONS AND QUILL.



END ELEVATION OF LOCOMOTIVE.

Like the New Haven locomotives mentioned above, the motors drive through a flexible connection to the drivers, the arrangement being as follows: Around each driving axle there is a hollow axle or quill which carries at either end a large circular casting having six arms projecting out between specially designed spokes of the wheel centers. Each of these arms is bolted to one end of a large helical spring, the other end of which is secured to the wheel center. This circular casting also acts as a center for the large gear rim which is secured to it in such a manner that the drive on the rim which comes directly from the pinions mounted on either end of the armature shaft is transmitted through ten small helical springs. In addition to giving a flexible drive this construction also permits each wheel complete individual freedom in negotiating track inequalities. The weight of the quill and its attached parts is carried in large bearings, forming part of the motor frame, having removable caps below to permit the convenient dropping of the quill with the drivers.



DRIVERS, SHOWING DRIVE THROUGH SPRINGS BETWEEN QUILL AND WHEEL.

Each locomotive is equipped with four Westinghouse 315 h.p. air cooled motors and Westinghouse non-automatic unit switch control. The gear ratio for the freight locomotives is 22 to 91, and for passenger locomotives 34 to 79. The former have a continuous tractive effort of 49,000 lbs. at 21 m.p.h., and the latter a tractive effort of 12,000 at 37½ m.p.h. The total weight of each locomotive is 260,000 lbs., distributed to give 48,000 lbs. on each driving axle.

CAB DETAILS OF 4-6-2 LOCOMOTIVE

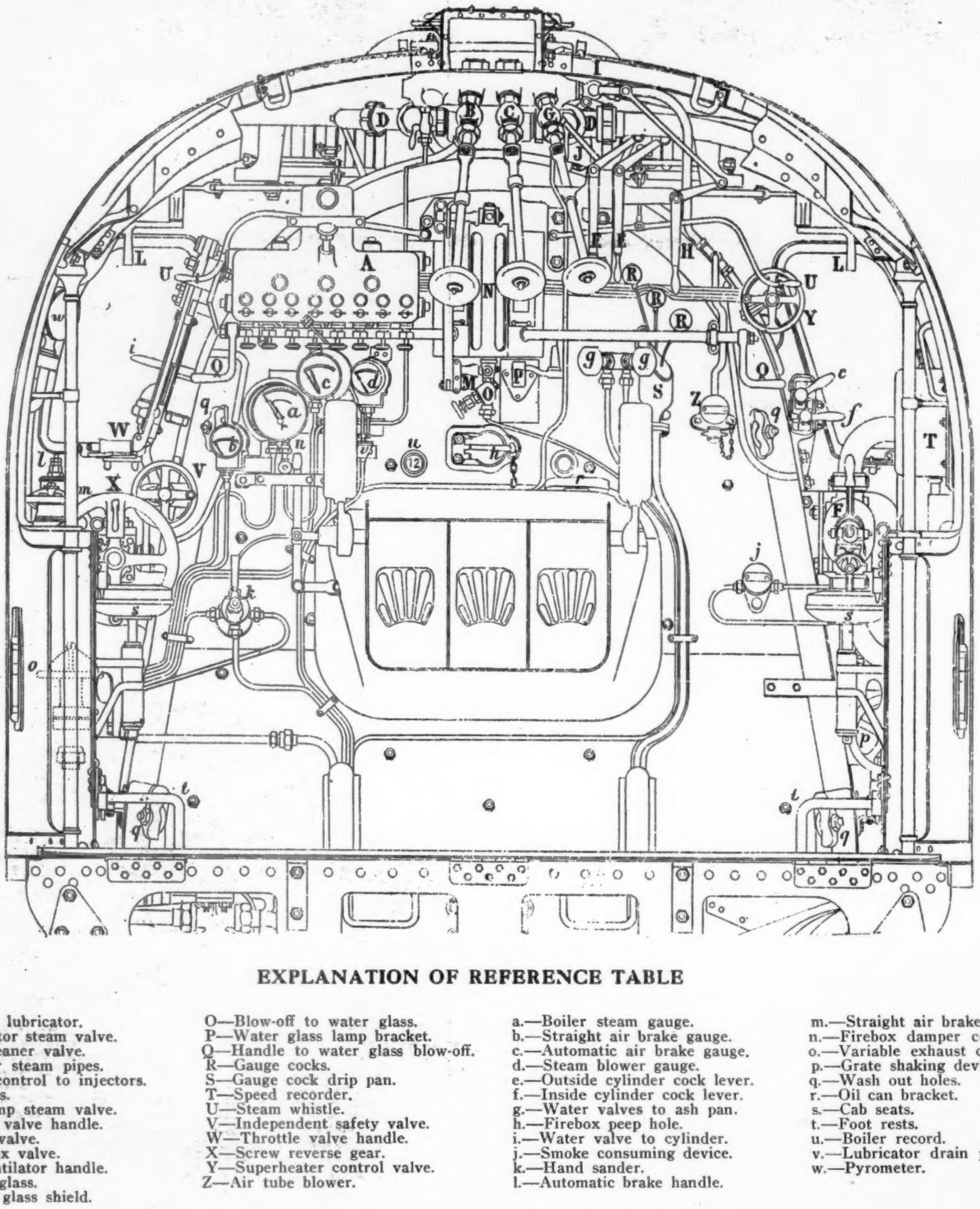
PARIS, LYONS & MEDITERRANEAN RY.

The extraordinary complication shown in the accompanying illustration of a foreign locomotive cab may convey a slight idea of what is demanded of an engineer engaged in handling a modern high speed passenger locomotive on European railways. The cab interior represents that of one of the new Pacific type locomotives recently completed for the Paris, Lyons and Mediterranean Railway, and the general arrangement must obviously appear unfamiliar when viewed in the light of American practice.

This engine is of the four-cylinder simple type, although in the operating details it follows closely that of the De Glehn compound which has remained the standard abroad for this service during the past decade or so. It will be noted that the equipment comprises a variable exhaust; manual control of the Schmidt superheater; control from the cab of ash pan dampers, and many other refinements not found in American locomotives. The large hydrostatic lubricator takes care of practically everything requiring lubrication, including the four cylinders, air pump and even the driving boxes. So far this road has not experienced any particular difficulty in lubricating where superheated steam is used, hence mechanical lubricators are not embodied in the design of these new engines.

A very prominent feature noticeable in connection with the general cab arrangement is the grouping of many important operating details on the right hand, or fireman's side of the engine. The injectors, for instance, are so located, as abroad, the fireman invariably controls the boiler feeding. He also takes care of the variable exhaust, handles the superheater damper and altogether assists more in the actual running of the engine than may be found anywhere in this country.

A very striking characteristic, which may be readily appreciated from a scrutiny of the illustration, is the disregard of comfort for the men embodied in the design. The cab seats are misnomers, and when using them it is almost impossible to see the road ahead. The engine crew, as a rule, remain on their feet throughout the run, and even this contingency is not prop-



EXPLANATION OF REFERENCE TABLE

A—General lubricator.
B—Lubricator steam valve.
C—Flue cleaner valve.
D—Injector steam pipes.
E—Steam control to injectors.
F—Injectors.
G—Air pump steam valve.
H—Blower valve handle.
I—Blower valve.
J—Sand box valve.
L—Cab ventilator handle.
M—Water glass.
N—Water glass shield.
O—Blow-off to water glass.
P—Water glass lamp bracket.
Q—Handle to water glass blow-off.
R—Gauge cocks.
S—Gauge cock drip pan.
T—Speed recorder.
U—Steam whistle.
V—Independent safety valve.
W—Throttle valve handle.
X—Screw reverse gear.
Y—Superheater control valve.
Z—Air tube blower.
a.—Boiler steam gauge.
b.—Straight air brake gauge.
c.—Automatic air brake gauge.
d.—Steam blower gauge.
e.—Outside cylinder cock lever.
f.—Inside cylinder cock lever.
g.—Water valves to ash pan.
h.—Firebox peep hole.
i.—Water valve to cylinder.
j.—Smoke consuming device.
k.—Hand sander.
l.—Automatic brake handle.
m.—Straight air brake handle.
n.—Firebox damper control.
o.—Variable exhaust control.
p.—Grate shaking device.
q.—Wash out holes.
r.—Oil can bracket.
s.—Cab seats.
t.—Foot rests.
u.—Boiler record.
v.—Lubricator drain pipe.
w.—Pyrometer.

erly provided for as the rounded shape of the cab sides necessitates a stooping position which is quite trying to maintain for any length of time.

They are very skilled in their work and obtain some really remarkable results. Engines of this type, with 400 tons behind the tender, are said to burn only 44 pounds of coal per mile, and despite their multitudinous parts are extremely light on oil. The latter reduced to the basis of American computation is not greater than $2.00 per thousand miles, and this despite the fact that four cylinders must be lubricated, with independent lubrication for each cylinder.

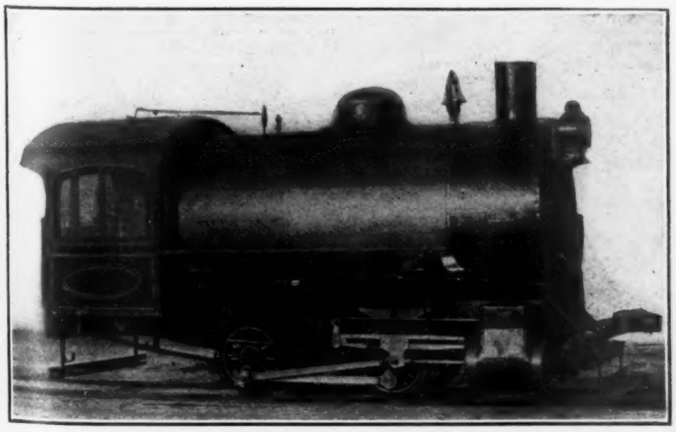
These economies may be very largely explained through the premium system which is universal on the railroads of France, and so extensive in scope that bonus payments are provided for practically everything, from making up lost time to saving box packing. When it is remembered that the pay of an engineer is not more than fifty dollars per month, and that it is possible to add some twenty dollars to this through judicious saving, it may be readily appreciated that the latter becomes a very important consideration. The negative results obtained by the premium system in the United States, where it has been tried, may be traced to the small amount in proportion to total pay which it is possible to earn under such systems. The men handling the engine herein illustrated do not object to the various cab ramifications, which might cause a grievance here, because they appreciate that through their intelligent use it is possible to add a considerable amount to their monthly pay checks.

In this effort they are, of course, tremendously assisted by the care exercised to provide proper upkeep for the locomotives. Their maintenance in France especially is fittingly viewed as a very serious matter, and nothing whatever is slighted or left undone. It may be possible that a realization of this fact on the part of the men conveys that with a perfect machine to work with perfect work may be logically expected from them. Whatever the secret may be, the fact must remain undisputed that the locomotive service over seas has been raised to practically the highest possible stage of efficiency.

A FIRELESS STEAM LOCOMOTIVE

A very novel locomotive design is shown in the accompanying illustration of a steam storage industrial locomotive, particularly useful where the fire risk is to be minimized.

This locomotive consists essentially of a large tank 84 in. in diameter and 16 ft. ½ in. maximum length, mounted on two pairs of 36 in. drivers, the cylinders, frames and other parts, exclusive of the boiler, being practically the same as on the usual locomotive. The tank is made of suitable strength for 200 lbs. pressure and is provided with a dome and small throttle valve of the usual type. A 4 in. dry pipe connects the throttle to a large Mason reducing valve in the front end from which branch pipes extend to each of the cylinders. The exhaust steam is carried out at the front of the saddle and through a pipe to the stack, a large separator being provided in the stack which takes out the water from the exhaust steam.



STEAM STORAGE LOCOMOTIVE.

The cylinders are 18 in. x 18 in. and the reducing valve is set for 60 lbs. pressure. With this pressure the tractive effort of the locomotive is 9,720 lbs.

In operation, the tank is filled about half full of water and is then connected with a steam line from the boiler plant until the pressure equalizes. When this occurs, considerable steam will have been condensed, but the water will have been raised to the pressure and practically the temperature of the steam supply. As steam is used, of course, the pressure falls and more water is turned into steam. For the locomotive here shown, it is stated that under ordinary circumstances it will not have to be charged any oftener than a regular locomotive has to take water, or say two charges per day. The loss by radiation will not amount to more than 3 or 4 lbs. pressure per hour.

This locomotive has a total weight in working order of 77,100 lbs. The driving journals are 6 in. x 7 in., and the tank has a capacity of 530 cubic feet. The brake is operated by hand, a large vertical brake wheel being provided in the cab. It was designed and built by the Lima Locomotive & Machine Company, Lima, Ohio.

NATIONAL RAILWAY APPLIANCE ASSOCIATION

Preparations are now being made for the annual exhibition of railway appliances used in the construction and maintenance of steam and electric railways, which will be given by the National Railway Appliances Association, at the Coliseum and First Regiment Armory, in Chicago, March 18th to 23rd, inclusive, 1912. This is the week during which the American Railway Engineering Association will hold its thirteenth annual convention, and the Railway Signal Association will hold its spring meeting. The Railway Appliances Association has been incorporated under the name of National Railway Appliances Association, with offices at 537 So. Dearborn street, Chicago. The arrangement of the main floor space in the Coliseum will be practically the same as last year, but the balconies will not be used. In order to provide for the increasing demand for space, the First Regiment Armory, adjoining the Coliseum, has been leased, which will give an additional 16,000 square feet of floor space.

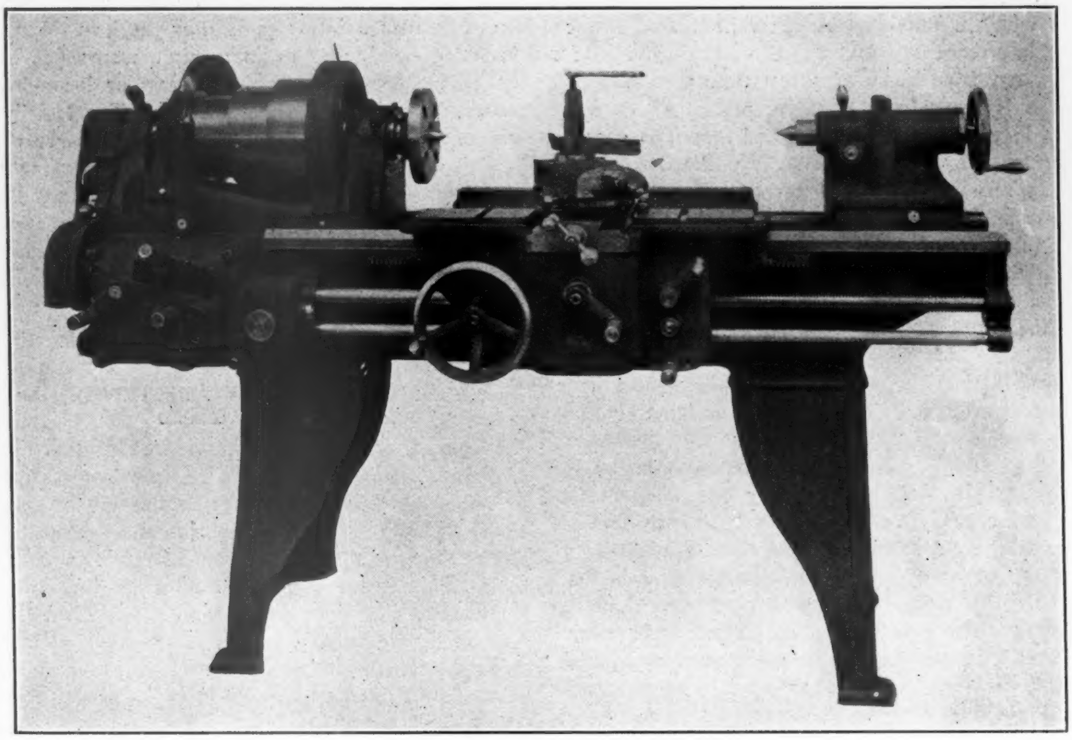
The price of the floor space will be 45 cents per square foot, the additional charge of five cents per square foot over last year having been made because of the necessity of buying fixtures this year, instead of renting them as heretofore. The first allotment of space will be made on or about November 1, 1911, by the Executive Committee of the Association. Therefore it is advisable to have all applications for space in the hands of the Secretary, Bruce V. Crandall, 1400 Ellsworth Bldg., 537 So. Dearborn street, Chicago, as early as possible.

THE PENNSYLVANIA TO USE CONCRETE POLES.—To avoid interruptions by severe storms or fires from meadow grass, as well as for durability and appearance, the Pennsylvania Railroad has constructed a reinforced concrete pole line designed to carry sixty aerial wires and two 1½-inch lead-encased cables for its telegraph and telephone circuits on the north side of its tracks across the five miles stretch of swampy meadow land between Manhattan transfer and the portal of the tunnels leading into the new passenger station in New York.

EXPORTS OF IRON AND STEEL FROM THE UNITED STATES in the fiscal year just ended will probably be $235,000 000 in value, against $184,000,000 in the former high record year, 1908. The total for the ten months ending with April, the latest period for which details have been compiled by the Bureau of Statistics, Department of Commerce and Labor, is in round terms $190,-000,000, and if the May and June exports approximate in each case those of April, the total for the year will be fully $235,-0000,000.

THE NEW "MORRIS" 16 in. LATHE

The accompanying photographs illustrate a new 16 in. quick change engine lathe recently placed on the market by the John B. Morris Machine Tool Co. The machine, while conforming in general to the practice of the leading lathe builders, has a number of novel features incorporated in its design which tend to considerably increase the productive capacity. It is a tool intended for heavy duty service, and is characterized by great driving power, together with strength in details to suit.



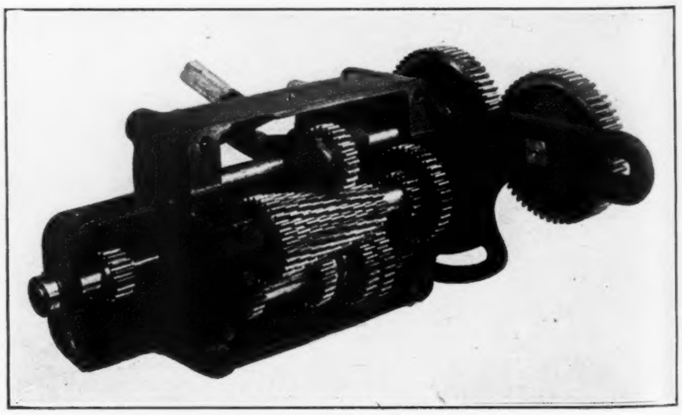
POWERFUL QUICK CHANGE ENGINE LATHE.

The driving cone, which is 3-stepped, has diameters 7⅛ in., 8⅝ in. and 10 in. respectively for a 3½ in. driving belt. The back gears are of the double friction type with ratios sufficient to give ample pulling power on large diameters and the frictions are of the toggle lever type, unusually large in diameter, and fitted with an automatic adjustment for wear. The spindle boxes are made of phosphor bronze and are oiled continuously from large oil wells in the pedestals. The front spindle bearing is 2¾ in. in diameter by 4½ in. long. The headstock is reinforced with an improved system of dropped longitudinal and cross ribs which are down below the shears of the bed. The reverse plate is carried on the outside of the head and is a double-walled one-piece casting in which the studs for the gears are supported at both ends.

In the quick change gear mechanism are found the usual cone and tumbler gear with a novel system of sliding gears through which 45 changes of feed or thread leads are obtained with the use of 21 gears. All feed changes are secured by means of the three levers shown on the front of the box, the one at the left being used only to secure the extreme range. The total range possible is from two to sixty threads per inch.

At the end of the lathe is seen the usual quadrant and quadrant gear for connecting up with the spindle so that it is possible to put on change gears to secure any special thread which might be required within the above range, making the machine capable of covering as wide a range of threads as can be obtained on a standard construction of engine lathes. A new feature in connection with this mechanism is the method of connecting it with the feed rod and lead screw. This is accomplished by means of a sliding gear operated by the knurled handle shown at the extreme right of the box, and is so arranged that when the lead screw is in operation the feed rod is at rest and vice versa. This construction makes the quick change box a complete mechanism within itself and permits it being taken off the bed without disturbing the adjustment of the lead screw or feed rod.

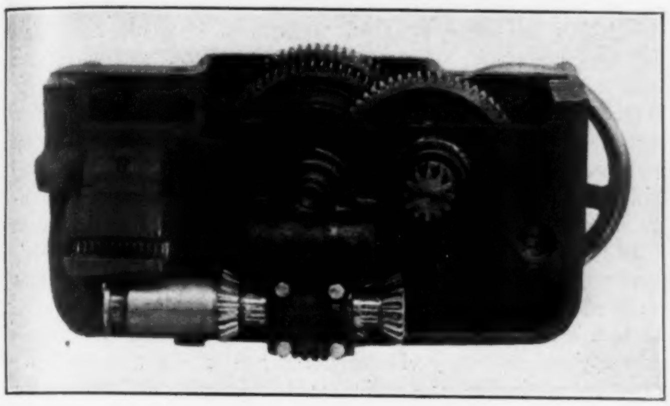
A one-piece box section casting forms the apron and all studs and gears are supported in the bearing at either end. It is supplied with the usual bevel gear reverse, which mechanism interlocks with the half nut, so that it is impossible to engage the lead screw and feed rod at the same time. To overcome the difficulty sometimes encountered in engine lathes due to the operator's inability to manipulate the revolving knurls for engaging feeds, owing to the high speed at which they revolve, a novel arrangement of clutches is employed. The frictions are of the expanding ring type, 5 in. in diameter, and engaged by means of toggle lever movement which insures ample driving power under the heaviest cuts. The shifting mechanism for these frictions consists of a single crank handle shown on the front of the apron. When this lever is thrown to the right it engages the longitudinal feed, and when it is thrown to the left it engages the cross feed. Since this lever is stationary at all times, it enables the operator to work up to a shoulder without the necessity of throwing out the feed and running up the carriage by hand; and in addition to this it is in a particularly convenient position for the operator to manipulate at all times. Provision



QUICK CHANGE GEAR MECHANISM.

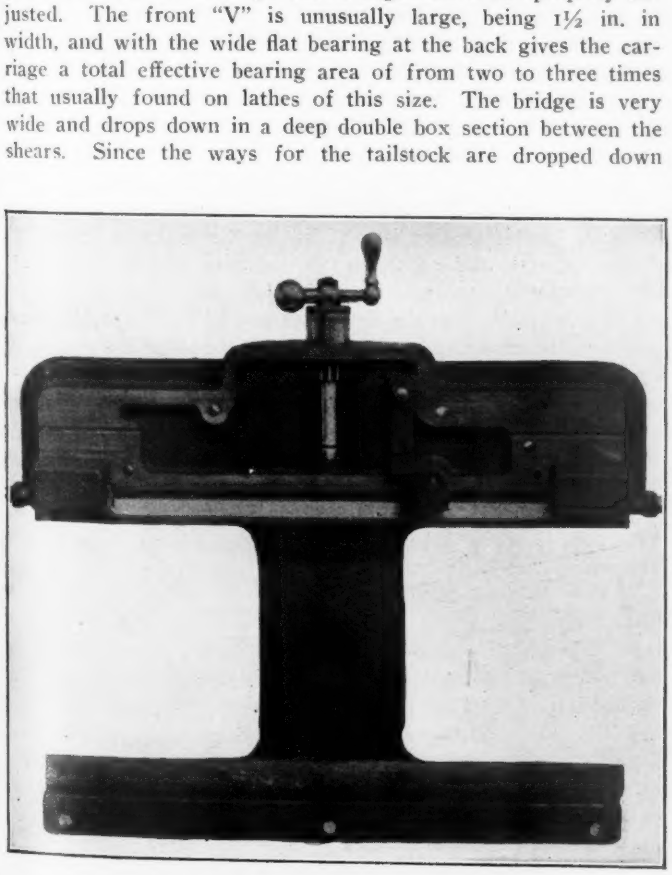
is made in the shape of a positive stop, which makes it impossible to throw the lever from one feed to the other without first pulling out the plunger pin in the handle, thus making it impossible to pass directly from the longitudinal to the cross feed, or *vice versa.*

The carriage, which has a bearing 26½ in. long on the bed, is carried on a "V" in front and on a flat surface at the back of the bed. It is held in position by a long flat clamp at the back,



DETAILS OF APRON GEARING.

and by means of two taper gibs at the front which bear on the machined surface directly under the front "V." These gibs from their location make it impossible for the carriage to lift or climb the "V" under any conditions, and at the same time will not throw the carriage out of alignment if not properly adjusted. The front "V" is unusually large, being 1½ in. in width, and with the wide flat bearing at the back gives the carriage a total effective bearing area of from two to three times that usually found on lathes of this size. The bridge is very wide and drops down in a deep double box section between the shears. Since the ways for the tailstock are dropped down



BOTTOM VIEW OF CARRIAGE.

below the ways for the carriage, it is not necessary to notch the bridge for clearance, and thus its rigidity is maintained.

The compound rest is made heavy to withstand the strains imposed upon it by the modern high speed steels. The clamping device for the swivel is of a new construction operated by a single belt which is located convenient to the operator. The clamping mechanism consists of a "V"-shaped clamping ring of a similar construction to that found on round column radial drills. This device, in addition to being very effective, leaves the bottom slide more rigid than it would be with the "T"-slot turned in it, and at the same time permits of very quick adjustment of the compound rest.

An unusually rigid construction is employed in the bed, which is 11¾ in. deep and 14½ in. wide. The front cross girth, which is directly under the front spindle bearing, extends clear up to the top of the ways in order to resist the twisting strain on the bed at this point. The legs are set in from the ends of the bed, thus shortening the span between supports on the bed and making use of the familiar cantilever form of construction. The tailstock is very massive of a box section and is arranged with the usual type of set-over for turning tapers. Its spindle is of steel 2 3/16 in. diameter and is clamped by means of a taper plug of the same construction as that usually found on the overarm of a milling machine. The tailstock is clamped to the bed by means of two large bolts coming up directly in front of and behind the tailstock spindle. These bolts reach to the top of the tailstock where the nuts are in a convenient place for the operator.

This lathe swings 16½ in. over shears, and 10 in. over carriage, and with a six-foot bed takes 2 ft. 8 in. between centers. With a six-foot bed the weight is approximately 2,100 lbs. That the machine is capable of continuous operation under heavy cuts will be evidenced by the statement that it will handle, without any signs of distress, a cut ¼ in. deep by ⅛ feed in 60 point carbon steel at a peripheral speed of 75 feet per minute.

M. M. AND M. C. B. CONVENTIONS

At a joint meeting of the executive committees of the Master Mechanics', Master Car Builders' and Railway Supply Manufacturers' Association, held at the Belmont Hotel, New York, October 24, it was decided to hold the 1912 conventions at Atlantic City. The Master Mechanics' Association will meet June 12, 13 and 14, and the Master Car Builders' Association, June 17, 18 and 19. At the suggestion of railway men it was decided to make a change in the entertainment features and the manner of handling them. This change is expected to do away with all entertainment fatures except the annual ball game. Informal dances will be held instead of the two grand balls. It is also understood that members of the two associations are to be given preference in the assignment of the accommodations at the headquarters hotel, but applications for accommodations to come under this preference must be in by December 1, 1911.

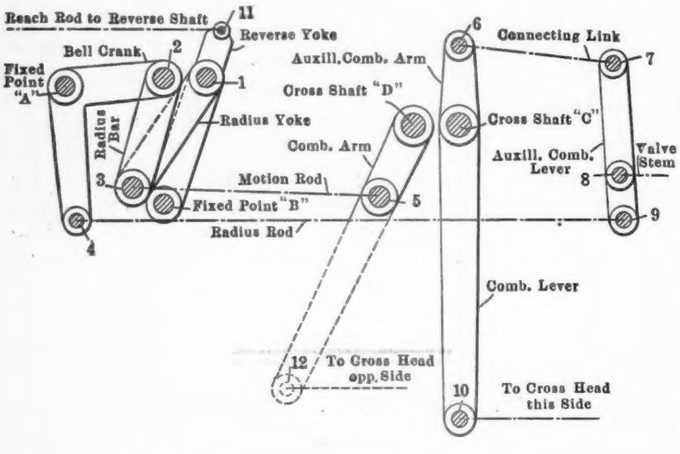
QUARTERS FOR DINING CAR EMPLOYEES

At Winnipeg, Calgary and Vancouver the Canadian Pacific in connection with the dining car department has in use three new buildings which have been erected at a cost of $15,000 for lodgings for the employees of the dining car department. Coming into these cities after a long run the men will not have to look up a hotel or boarding house, but will go to the new buildings. These houses are built to accommodate sixty-two employees and are of the most modern construction in every respect. Everything is free, including the laundry. Conductors, chefs and waiters all have separate quarters, which include baths, bedrooms, reading rooms, libraries, cardrooms and billiard rooms. Gardens beautify the premises and the men have all the comforts of home. It is compulsory for the men to take a bath and a change of underwear after each trip and a check system has been installed to insure that the men comply with this rule. When a car is called away on short notice at night it is not necessary to seek for a crew as the men are right at hand when needed. It is expected that the C. P. R. will build these houses at all divisional points.

STYLE "B" PILLIOD LOCOMOTIVE VALVE GEAR

A number of important changes have recently been made in the details of the Pilliod locomotive valve gear, which are of much interest in view of the ingenuity displayed in the elimination of formerly existing parts, and the fact that in the redesign, known as style "B," the imparting movement, obtained from the crosshead only, has now become permanently indentified with the gear. This clever mechanism has been described and illustrated in this journal,* and while basically it remains the same, it has been so simplified and re-arranged that the claim advanced that all objectionable features which may be found in any other gear have been eliminated seems to be well founded.

Referring to the accompanying drawing, a brief description showing how results are obtained is necessary as a preliminary



to the study of the motion: Point (10) of the combination lever is connected to the crosshead with a union link. The combination lever transmits the motion through the auxiliary combination arm to the point (6) which is connected to point (7) of auxiliary combination lever by means of the connecting link. This gives the lap and lead travel of the valve through point (8) which is connected to the valve stem. Point (C) is a cross shaft extending across the engine to opposite crosshead through cross shaft (D). The motion is transmitted to point (5) which is connected to point (3) by the motion rod. The oscillation of the radius yoke around point (1) raises and lowers the radius bar. This is connected at point (2) to the bell crank which in moving around point (A) transmits the motion of the radius rod through point (4). The radius rod in turn acts upon the auxiliary combination lever and gives the accelerated movement to the valve through point (8) which is connected to the valve stem. Point (11) is connected to the reverse lever by the reach rod. The movement of the reverse yoke, at the various points of cut off around point (B) will cause point (3) to move in various planes.

The question has been raised at various times as to whether or not there is more distortion from a crosshead connected gear than from a crank and crosshead connected, and in this connection it may be asserted that such distortion cannot possibly exist in the former construction, as if present it would not be possible to keep the piston within the cylinder. It makes no difference what position the wheel or main crank is in, the piston must keep within its limits of travel. The angularity of the main rod always remains the same, and whether the centre line of axles is up or down the piston will travel to the exact point, or the same point from the front end of the 90 degree position of the crank, and cannot possibly be modified.

The main crank could move from the center line of the cylinders 3 in. below or 3 in. above, and it would not affect the complete stroke of the piston. The piston will travel the same identical distance from the end of the stroke to the 90 degree travel of the crank, regardless of the above variation. Admitting this to be true there can be no distortional effect in a crosshead connected gear, because while one piston is in mid position the other is in natural position, or at the completion of the stroke. The piston must travel the same distance at all times, and the valve gear maintains its same relative position regardless of the crank travel. It is well established that the combination lever of the Walschaert valve gear requires no modification within or during its operating period, but it is necessary to constantly change the eccentric rod and eccentric crank connection of the main pin to maintain uniform steam distribution.

In the crank and crosshead connected gears in practical use the valve gear frame is attached to the engine frame and the movement of the engine up and down on its springs changes the position of the valve gear in relation to the eccentric crank connection. For instance, if the locomotive was stationary and raised on its springs it would raise the gear and change the angle of the eccentric rod, since the eccentric crank, which is attached to the main driver would remain stationary, thereby causing the link to be drawn toward the eccentric crank. If the engine on the other hand were lowered on the springs the link would be moved away from the eccentric arm thus distorting the valve movement. This could, of course, happen when the engine is taking curves, or running over irregularities in the track.

Referring to the diagramatic sketch it will be easily seen that when the line of motion is changed by the engine settling 2½ in. the eccentric rod on the bottom quarter will be long, and short on the top quarter. If made short on the long side it will be doubly short on the short side and *vice versa*, and hence in attempting to square the gear it must be done by changing the crank circle. The style "B" gear was designed to overcome these objectionable features and at the same time give as good results as now obtainable with any outside connected gear and with no more wearing surfaces.

The new gear will no doubt be studied with interest by those who while satisfied with economy and efficiency results obtained with the Stephenson and Walschaert, still desire a gear which is free from the objections commonly made to those types, and one that can be applied to old power at a minimum cost. It will be of special interest to those who contemplate replacing the link motion with some form of outside gear as it can be applied without any modification of the engine. The Pilliod Brothers Co., of Toledo, O., manufacturers of the gear, say

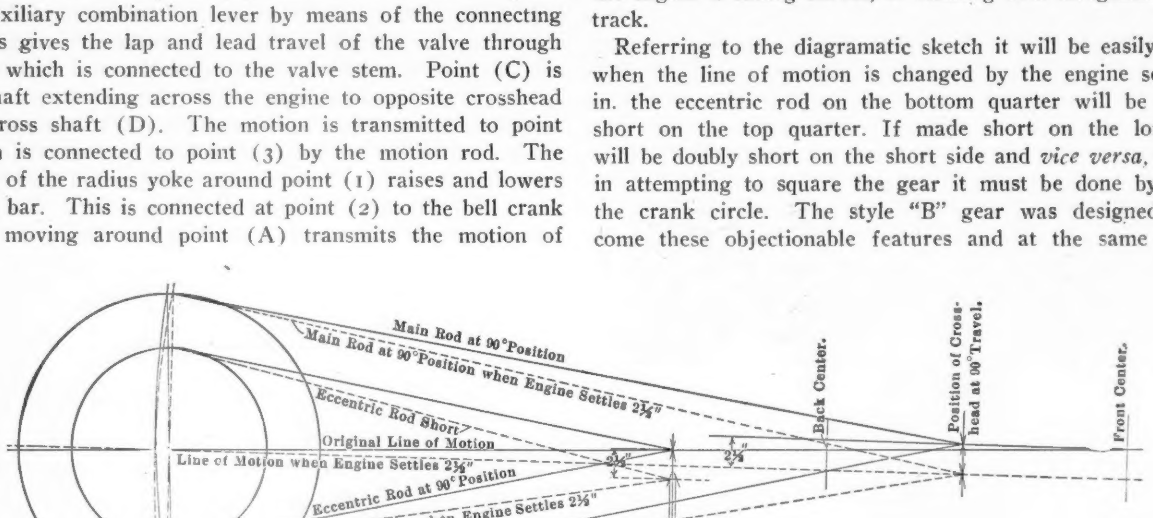


DIAGRAM SHOWING EFFECT OF VARIATION OF CENTERS OF CYLINDERS AND AXLES.

* See AMERICAN ENGINEER, Jan., 1911, p. 22.

that it can be applied in 48 hours, this, of course, largely resulting from the fact that new main crank pins are not required. All parts, including frames, are standard for any type or class of engine, either inside or outside admission, with the exception of the combination lever, which differs in length according to the piston stroke.

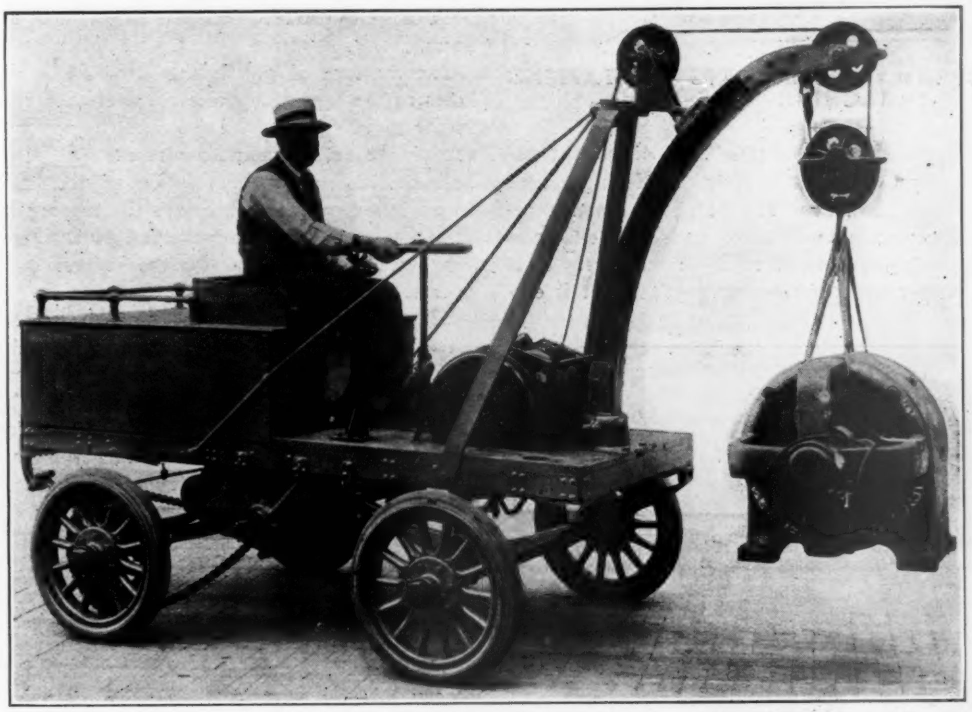
In the re-design careful attention has been given to the proper proportion of the parts to insure the necessary strength throughout. The liability to failure in service, however, is extremely remote, as the arrangement being entirely without eccentric straps, link block pins, etc., cannot be identified with those well known sources of trouble. The accessibility of the gear to inspection is also a very important part, and the fact that practically nothing is concealed would no doubt result in the early discovery of a defect which might escape observation in other types. The details have been worked out with care, especially those in connection with lubrication. Each bearing has an oil cellar of special design, automatic in its feed, and so arranged that any sediment which might pass with the oil from the outside can in no way get into the bearings. The roundhouse men cannot make any change in the gear as there are no rods to lengthen or shorten.

In addition to the above style "B" gear which it is the intent of the manufacturers to feature as the ideal motion for all conditions they have also designed what is known as style "C," which will interest those who want a crank and crosshead connected gear without links or blocks. This is an outside gear with the same number of parts and bearings as the Walschaert, and differing from it only in that the links and blocks are replaced with a reverse of the Marshall type. The elimination of these latter parts would suggest that the cost of maintenance should be less, but the design retains the crank connection, and in general does not embody the feature of simplicity which has been pointed out in connection with the style "B" gear.

AN INTERESTING SUPERHEATER LOCOMOTIVE performance is reported by the C. N. R. locomotive 266, built by the Montreal Locomotive Works, and equipped with the Schmidt superheater, which ran 378 miles from Edmonton to North Battleford and back to Vermilion with six or seven coaches on a total coal consumption of about eight tons, this efficiency being largely due to the superheater.

A TRUCK CRANE OF GENERAL UTILITY

The urgent need for a device to handle with expedition and at low cost material of any description which must be moved from place to place within moderate confines of space has been long apparent, not only in connection with the larger shops, but equally so with locomotive terminals and at storehouse yards, etc. To solve the problem the General Electric Company is now placing on the market what it has designated as the "Battery Truck Crane," an electric vehicle which has a swinging crane mounted on the front end. The crane hook is raised and lowered by a one-ton hoist mounted on the front end just back of the crane, the motors driving the hoist and the vehicle being operated from a storage battery mounted on the rear end.



THE BATTERY TRUCK CRANE.

The time, money and step-saving applications of this crane may be classed under three heads—hoisting, hoisting and carrying on the hook, and towing trailers, yet a given movement of material may involve two or all of these. In case where material which may be subdivided into parcels of one ton or less, has to be deposited within a 6 or 8-foot radius, and this action does not require that the parcel be moved through a vertical distance of over 10 feet, the machine is brought into an advantageous position; the brakes are set, and the vehicle remains stationary as the boom of crane moved back and forth between the picking up and depositing points. In this manner the battery truck crane may be employed to load or unload box cars, gondola cars, etc., and a considerable saving effected both in time required and the number of men employed.

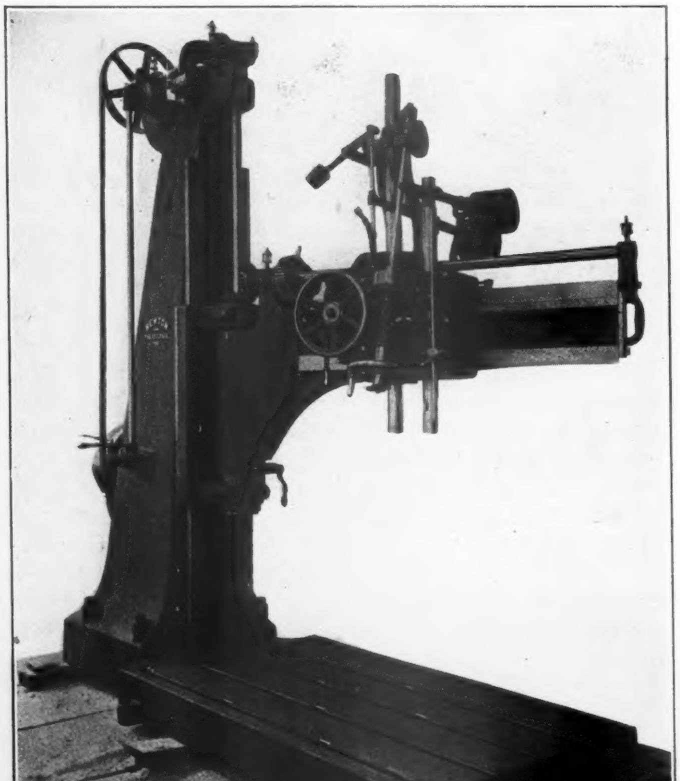
When material, in small or large quantities, has to be moved less than 400 feet or, in small quantities, to any distance, the article is lifted by the hook, conveyed to its destination by the vehicle, and placed on the floor, on a rack, or a high pile, as desired. The short wheel base permits making short turns, so this machine may readily be driven about shop aisles, congested piers or among piles of material in a storage yard. By this pick up and run method sixty 800-lb. barrels of plumbago were moved 300 feet in one hour, only one helper being required; one hundred and fifty 300-lb. boxes of rubber were conveyed 75 feet and loaded into a box car in 50 minutes, three boxes slung together and a round trip made every minute. In a storeroom boxes of angle and flat iron weighing about 1,000 lbs. each were carried 30 feet and stacked in sorted and orderly piles at the rate of 40 boxes an hour.

For the miscellaneous transfer of large quantities of package freight or other material through a distance of about 400 feet the best procedure is to use the battery truck crane to tow trailer in trains of about four. The number of trailers per train and the number of trains will depend upon the distance, character of load and time taken to load and unload the trailers. Twelve is the usual number, and these are divided into three trains. Thus the battery truck crane keeps 600 sq. ft. of loading deck working to its maximum capacity. This would be equal to a single vehicle 5 feet wide by 120 feet long, or to twelve individual power operated trucks each having 50 sq. ft. of space for carrying material.

The truck crane is designed for a high drawbar pull, its maximum being 2,000 lbs., and equal to that of a five-ton locomotive on rails, sufficient to spot a car and to readily handle loads of from five to eight tons on trailers.

HIGHLY DEVELOPED RADIAL DRILLING AND TAPPING MACHINE

The interesting machine herein illustrated is a prominent example of the development which the Newton Machine Tool Company, of Philadelphia, Pa., has brought about through recent redesign of several items in its output, several examples of which have previously been noted in these columns. It is worthy of special consideration, in view of the fact that it embodies many distinctive points which must necessarily appeal to those who use this particular machine tool.



NEWTON DRILLING AND TAPPING MACHINE.

A study of the design indicates primarily a recognition of the requisite that the framework should be sufficiently heavy and so proportioned as to successfully resist all vibrations of its own, so far as practical. That is to say, that while vibrations to a certain extent are unavoidable, still there should always be sufficient strength and solidity in the frame, so that the machine's vibrations will not materially affect the working qualities of other machines in close proximity to it. Where the framework, so called, which in the case of this tool may be roughly divided into work base, upright and arm, is light and weak, so that its own necessary vibrations become a tremble, then the good working qualities of the machine itself will not only be affected, but the tremble, when a uniform motion is kept up, will become an impulse like that of a pendulum and communicate itself to other parts of the shop. It is very evident that in the admirable proportions of the design under consideration, all such vibrations have been eliminated, or at least minimized to a degree which renders them of no import.

The arrangement of the various parts is of the simplest nature, and the tool generally is free from the flimsy refinements which characterize many others intended for the same line of work. The arm saddle has square lock bearings on the upright and there is a reversing fast vertical traverse. The trunnions are mounted in roller caged bearings, and every attempt has been made to produce this part in the most substantial and rigid form.

The machine is particularly adapted to drilling and tapping holes as the tapping spindle revolves at a reduction of 2¼ to 1 to the speed of the drilling spindle by which it is driven. In operation the drilling spindle with the drill in place is located, the hole drilled, and one revolution of the hand wheel, measured by an index on the dial, brings the tapping spindle with the tap in place over the already drilled hole. The drive to the tapping spindle is engaged for the reverse motions by the clutch operated by the small lever.

There are four changes of speed by means of a cone in addition to two to one back gears and four changes of gear feed to the spindle with adjustable automatic release. The spindle is counterweighted and has hand adjustment. The diameter of the individual spindles is 2 13/16 in.; distance from center of trunnion to center of inner or drilling spindle, 64 in.; length of feed, 17 in.; maximum distance from base to the center of spindle, 81 in.; size of work base, 7 ft. by 4 ft.

SCIENTIFIC MANAGEMENT

At a recent joint meeting of the Franklin Institute and the American Society of Mechanical Engineers a paper was read by Wilson E. Symons, of Chicago, combatting the Brandeis theory that by scientific management the railroads could save $1,000,000 per day. Mr. Symons took the attitude that the practical experience of railroad men had already reduced the costs of operation to a minimum that could not be reduced by "mere theorists."

In the ensuing discussion, Samuel Vauclain, vice-president of the Baldwin Locomotive Works, agreed generally with Mr. Symons. As the prices of materials are standard, the saving of $1,000,000 per day, if made at all, he said, would have to come out of the pockets of the workmen. "I believe in scientific management," he said, "but I do not believe in espionage that binds men down and makes them feel that they are mere automatons, driven by their employers, just to get the greatest amount of work out of them. Nothing is so scarce in this country as good labor, and it should be rewarded."

The Tenth Annual Convention of the National Machine Tool Builders' Association was held at the Hotel Astor, New York, Tuesday and Wednesday, October 10th and 11th. The following officers were elected: President, E. P. Bullard, Jr., Bullard Machine Tool Co., Bridgeport, Conn.; vice-president, Fred A. Geier, Cincinnati Milling Machine Co., Cincinnati, Ohio; second vice-president, A. T. Barnes, W. F. & John Barnes Co., Rockford, Ill.; treasurer, A. E. Newton, Prentice Bros. Co., Worcester, Mass.; secretary, Charles E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. The next semi-annual or spring meeting will be held in Atlantic City, N. J.

Copper May Be Welded by the use of a mixture of equal parts of boracic acid and phosphate of soda. The mixture is used in the same manner as in welding iron or steel, but should first be dried.

SOME EXPERIMENTS WITH TRUCKS

In the summer of 1910 an extremely valuable series of tests were conducted by Professor Louis E. Endsley, of Purdue University, to determine the running qualities of freight car trucks that are held reasonably square as compared with those constructed in such a way as to be free to get out of square. These tests, which have been fully described and illustrated in this journal,* were on invitation of the American Steel Foundries at Granite City, Ill., and were probably the most thorough in scope ever attempted to get at the real facts in connection with the subject.

Supplementing this information, however, George G. Floyd, mechanical engineer of that company, who collaborated with Professor Endsley in the tests, presented a paper before the September meeting of the Western Railroad Club in which further details of a most interesting and valuable character were made apparent. Mr. Floyd said in part as follows:

There were many things developed in the tests in the way of incidentals—sidelights, I might say—apart from the main tests, that are not fully set forth in the published report. It is my purpose to discuss some of these incidentals. After our investigation of the square and loose truck in service and before the testing plant was built, we had formed certain conclusions as the result of the investigation, as well as some opinions based upon the statements, experience and judgment of several railway engineers. While these conclusions and opinions had to be revised somewhat after the tests were run, our conclusions were in the main correct as to theory and as to what the results might be, and had to be revised only because the material effects had been somewhat underestimated.

For instance, it did not take long to discover that trucks in service did get out of square; that is, in rounding a curve the side frame on the inside of the curve would move ahead of the frame on the outside of the curve. Just how much was a matter of doubt, or I might say, a matter of calculation, rather than of actual measurement. The greatest amount that any one suggested was one and one-quarter inch. We were hardly prepared to find that it was nearly as much as three inches. We had expected to find that there might be ten to fifteen per cent. difference between the curve friction of loose and square trucks. We found as much as one hundred and fifty per cent. between the best square truck and the worst loose truck. We had anticipated that the load on the truck and its speed would regulate the amount the truck would go out of square, but it would seem from the tests made that the truck would go out of square approximately the same amount every trip around the curve regardless of its weight and speed. In fact, when it was merely pushed around the curve, slowly by hand, it would go out of square, the same amount as when it went around at high speed.

It was evident—as each truck tested went out of square an amount peculiar to itself—that there was something about its construction that acted as a stop to prevent further movement. Probably a wedging of the axle against the opening in the back end of the box and against the wedge and brass. It was noted in that type of arch bar truck in which the columns were riveted securely to the channel that the truck went out of square a less amount than those trucks in which the columns were bolted to the channel. This riveting of the column to the flanges of the channel made one less loose joint, and it may be that this one less loose joint introduced a stop at the columns or column bolts, which brought the truck to a bearing in advance of the stop furnished by the journal and box. There was also found an indication that the older a truck was in service, the more it would get out of square, this being no doubt due to a wearing away of the parts that stopped further movement of the truck, as well as a gradual loosening of the parts intended to hold the truck in square.

An interesting experiment was made to determine what effect the time of service would have upon those parts of an arch bar truck that are supposed to hold the truck square. A car was accidentally found in the yard that had been out from the contract show less than a month. It was a 50-ton truck of heavy construction, had cast steel truck columns bolted to a heavy channel, with two long bolts reaching through both columns. These bolts were tight, as were all bolts about the truck. The truck was put upon the testing plant and showed a very good test, one side frame moving ahead of the other only ¾ in., while a duplicate of this truck in service one year showed a movement of a trifle over 1¼ in., and a duplicate in service eight years showed almost 2-in. movement.

When trucks are new, all the surfaces bolted together being rough and the bolts tight, the friction between the parts will prevent all but a slight movement. It is this small initial movement of parts that brings about the final general looseness of the whole construction. The high points of the rough joint wear away, allowing the bolts to become loose, and then there is a still greater loosening of the parts in general by abrading, polishing or wearing away by friction. A bolted joint of this character is probably successful only when it is possible to so design it that all initial movement will be prevented. It only takes a small movement of the spring channel to give a considerable motion to the side frames, one ahead of the other. One-sixteenth of an inch motion of the channel under the spring seat will allow the side frame at the opposite side of the truck to move forward or backward about ¾ in. or ⅞ in.

That this initial movement exists in an arch bar truck, even when new, is not surprising when it is considered that the holes through the upturned flange of the spring channel for the horizontal column bolts are drilled 1/16 in. larger than the bolt; the holes in the arch bars are drilled 1/16 in. larger than the column bolts, and the hole through the column is cored usually ⅛ in. larger than the bolt passing through it, a possible 3/16 in. to 5/16 in. looseness to start with in the fit of the bolts. One does not have to look far to find reasons why the arch bar truck is a loose truck.

The fact that the arch bar truck does get out of square on a curve, the movement increasing with the age of the truck as indicated in the tests made by Professor Endsley, probably accounts for the trouble and expense for the upkeep of columns, column bolts, spring plank, bolts, etc. There is a continual motion and straining of parts at this point. It is impossible to keep the bolts tight, great trouble to keep them even in place, and it is quite natural that the repair account should be heavy if the joint is to be kept up, and it is quite natural, if the joint is not kept in proper repair, that the truck should fail to give the expected service results.

In reference to the connection between the spring channel and one-piece cast steel side frame, the tests demonstrated that a bolted connection was of little or no value as a means for making a tight immovable joint, that would hold the truck in square. The bolts were invariably found loose, and even after being tightened up thoroughly just before running a test, a very few runs would soon loosen up the joint. An extended examination of cars in service indicated that the bolt connection was of little value, as the bolts were nearly always found loose. On the other hand, an investigation covering a period of almost two years, and including several thousand cars, showed that the riveted joint was developing no signs of looseness, and was performing well the duty for which it was designed.

An occasional loose rivet was found, but one or even two loose rivets in a joint composed of a total of eight would indicate a looseness due to an imperfect application of the one or two rivets, rather than a looseness caused by service. The nature of the joint is such that road service could not loosen one or two rivets without loosening the whole joint. It was taken for granted that tight rivets presupposed a tight joint, and a tight joint meant a square truck. (It has been found, however, that tender trucks require more rivets than car trucks.) The Granite City tests confirmed the presumption that the riveted connection between the spring channel and side frame was a tight connection, which would remain tight in service and would hold the truck in square. Several of such trucks in service were tested and while the registering apparatus indicated a small movement it was not sufficient to influence the flange friction because the indicated movement was largely a changing in the perpendicular of the top of the side frame, due to the rigid connection between the two side frames being located some 12 in. to 15 in. below the top of the journal boxes, where the load is delivered to the axles. There was also a small amount of twisting of the side frame lengthwise along a line connecting the top of the two oil boxes on the same side of the truck, that was registered, as if it was a movement of the truck in and out of square. This same movement—in about double the amount—was also noted on the one or two arch bar trucks tested that were so new in service that they remained practically in square during the tests because the spring channel connection had not worked loose to any extent.

Professor Endsley's report shows that there is quite a material difference in curve friction in favor of a square truck, as against a loose truck. An amount of difference sufficient to affect the coal pile, life of rail, wheel maintenance and train resistance. Reducing the results obtained on the test track to a five and one-half degree curve brings out some interesting and somewhat startling information. A five and one-half degree curve is selected because it is possibly an average curve, and also because it makes a division by an equal divisor. The small fractions are left out in order to make round numbers. The drawbar pull in pounds per ton is found to be 9½ lbs. for the best square truck; 13.7 for the worst square truck; 11 lbs. for the best loose truck, and 17 lbs. for the worst loose truck. Broadly speaking, the difference between the square and the loose truck is due to a difference in truck construction.

The difference between the best and worst square truck is due almost entirely to wheel condition. In tabulating the re-

* See American Engineer, May, 1911, p. 192.

sults, as a matter of convenience, all trucks that went out of square one-half inch or less were classed as square trucks; so the difference in friction between a truck absolutely square and one out of square one-half inch should be deducted from the total difference between the best and the worst square truck—the balance is chargeable to wheel condition. However, the difference between a truck square and one out one half inch is a small amount. This fine line was not conclusively drawn in the tests, because of lack of time. The difference between the best and the worst loose truck is probably more evenly divided between that coming from truck construction and that resulting from wheel condition.

The difference between the best square and the best loose truck is favorable to the square truck by 15.8 per cent—and as between the worst square and the worst loose, 24 per cent. in favor of the square truck. In both cases the difference may be said to be a difference in truck construction. As between the best and the worst square truck, the difference is 44 per cent., largely wheel condition. Between the best and the worst loose truck there is a difference of 54 per cent.; possibly somewhere near evenly divided between truck construction and wheel condition. The difference between the best square and the best loose truck is favorable to the square truck by 15.8 per cent.—and as between the worst square and the worst loose 24 per cent. in favor of the square truck. In both cases the difference may be said to be difference in truck construction. Between the best and the worst square truck the difference is 44 per cent., largely wheel condition, and between the best and the worst loose truck there is a difference of 54 per cent., somewhere near evenly divided between truck construction and wheel condition. Between the best square truck and the worst loose truck is 79 per cent. The difference between the worst loose truck when run as a loose truck, and the same truck squared and run as a square truck was somewhere near 40 per cent. in favor of the truck squared, the difference being entirely due to truck construction.

The figures just given are from specific tests of specific trucks, and it probably hardly correct to undertake to construct a series of averages from them when it is considered that the averages used in calculating train resistance for actual service must of necessity represent the average resistance of all trucks, as they come in service. Therefore, it might be well to state that the average difference between all the square trucks and all the loose trucks tested was approximately 24 per cent. in favor of the square truck, based on a five and one-half degree curve. An average is the mean between two extremes. If the maximum and the minimum are near and close to the average, there is small chance to close up the gap between the average and the maximum in an attempt to reduce the average. But, if the maximum, and the minimum are comparatively widely separated, and the units in between are valuable, there is a greater chance to reduce the average and an effort is worth while. It is probable that little is known of the actual maximum and minimum that make up the average train resistance as used in every-day practice.

It would seem that some information has been developed along this line by the test made last summer, and the figures quoted above are possibly most interesting from this point of view. The tests show there is a difference of almost 80 per cent. between the maximum and minimum, due to both truck construction and wheel conditions and approximately 40 per cent. due to truck construction alone. A difference certainly—sufficiently material—to justify an elaborate and serious investigation by the railroads.

Several railroad men who visited the plant during the tests were forcibly struck with the idea that it was possible car wheels were allowed to run too long, and it might be better economy to remove them sooner. When the theory and reasons are known, it is not surprising that the curve friction of a loose truck should be greater than a square truck. Some very interesting experiments were made by whitewashing the rails on the curve, and noting the difference in contact between the wheel and the rail with the truck square and loose. When a truck was run square, there was only one point of contact between the wheel and the rail. This was on the ball of rail and in the deep part of the throat of the flange of the wheel. When the truck was run loose, there were two distinct points of contact, one on top of the rail and one on the side of the rail, there being from 1/8 in. to 3/8 in. between these two lines, depending upon how much the truck went out of square. In this case the whitewash was left on the ball of the rail, and the throat of the wheel did not show any contact with the ball of the rail. When the truck was stopped on the whitewash and run back, the end of the mark on the side of the rail made by the flange was from 1 in. to 2½ in. in advance of the end of the mark on top of the rail, made by the tread of the wheel. It could be seen, when the truck was in this position, by sighting along the edge of the rail, that there was no contact between the throat of the flange and the ball of the rail.

When the square truck was rounding the curve, the throat of the wheel being in contact with the ball of the rail, and the axles square with the track, the outside wheel would climb up on the rail, enlarge itself an amount sufficient to make up for the difference in the length of the inside and outside rails, and the wheels would go around the curve without slipping—the friction being all rolling friction. But, when the truck was running as a loose truck and got out of square, the throat was not in contact with the ball of the rail, and the flange being in contact with the side of the rail, acted as a shoulder so that the wheel could not move over on to the throat and climb the rail, therefore either the outside or the inside wheel had to slip the difference between the length of the two rails.

When the truck is running square, the friction between the wheel and rail is rolling friction, but when the truck is running loose and gets out of square, there is just as much rolling friction as there was before and in addition there is sliding friction between the flange and the side of the rail, which must be considerable, and the slipping or sliding of the tread of the wheel, on the top of the rail—because of the difference in the length of rails, and the inability of the outside wheel to enlarge itself, owing to lack of throat contact with the ball of the rail. This was plainly noticeable by listening to the noise the truck made in going around the curve. When the truck was square it made just a single rumbling noise, quite natural to a vehicle of this kind, but when running loose, in addition to the ordinary rumbling noise could be heard a loud flange song, and a distinct high sounding and piercing noise caused by the tread slipping on top of the rail. The latter noise was not a continuous one, but intermittent in very short intervals. The flange song was a continuous noise.

On a five and one-half degree curve, in the distance a 33-in. wheel makes in one revolution, the outside rail is about ½ in. longer than the inside rail, and with a loose truck this means that either the outside or the inside wheels must slip this one-half inch every revolution, and if the outside wheels do the slipping they not only have to overcome the friction between the tread and top of rail, but also the friction between the flange and side of rail. It is possible that the inside wheel does most of the slipping.

There is also one other source of increased friction in the loose truck, which is sliding friction. When a truck is running out of square, the axles are not square with the track, therefore the wheels are not revolving in a plane parallel with the direction of the rails, and if it were not for the flanges, the tendency of the wheels would be to run to the right, or the left, as the case might be. The natural track for the wheels to make would be one diverging from the rails, and they would only track in a line with the rails by a certain amount of slipping. This point can be better illustrated perhaps by presuming the front wheels of a wagon turned the necessary amount to go around a street corner, and then locked in this position. One can readily see it would require an extra effort on the part of the horses to pull the wagon, with the front wheels so turned and locked, in a straight line. The front wheels would revolve, but much slower than the rear wheels, and they would also slip along the pavement.

It must be this slipping that causes the increased friction in loose trucks going out of square from nothing up to one inch, and before the flange begins to make a contact with the side of the rail. It will be noticed from Professor Endsley's report, tnat there is a big jump in the friction between an inch, and an inch and one-half out of square. It is thought that the increase in friction up to one inch out of square is caused by the gradual increase in the slipping action just noted above, and that along about this point is where the flange begins to make the sliding contact against the side of the rail. Of course, it might be said that these tests, as they deal almost entirely with curve friction, do not interest the road that has almost all of its mileage straight track. This would be taking a somewhat narrow view of the matter. Owing to the great exchange or interchange of cars between the different railroads, it is possible the man on a road full of curves would be very much interested in the kind of a truck his straight track neighbor puts under his cars.

The tests were made for the sole purpose of determining, if possible, the facts regarding the difference between trucks that run square and those that run loose, as there seems to be a great difference of honest opinion among rilroad men, regarding the merits of each type of truck with apparently no convincing data at hand on which a final judgment could be based. The tests were made in the only manner in which it was possible to make them, considering the particular facts it was desired to determine. The results of the tests and experiments were given out because, first, they are tests that have never before been made so far as is known, and second, the data secured were considered of such value and importance that they would be at least passively appreciated by the railroad official who is interested in the economics of railway operation, and, third, because the majority of railroad men who knew the tests were being made requested that they be furnished with full results.

It is not the idea that these tests are final, nor that they rep-

resent absolutely service conditions. They were given out merely for what they are worth, and in so far as they go. They are considered as a preliminary to a more serious test that it is hoped will be made by the railroads themselves. It is felt, however, that the tests are a close approximate to what will be found in actual service, and are of sufficient value to be entitled to full consideration, pending more elaborate dynamometer tests in actual service.

HEAVY SWITCHING LOCOMOTIVE

CHICAGO & WESTERN INDIANA RY.

The heavy character of the switching requirements on the Chicago & Western Indiana Ry. has brought about a remarkable development in locomotives intended exclusively for this service. A prominent example of this increase in size, weight and power may be found in the engine herewith illustrated, which is one of ten recently built for this road by the Lima Locomotive and Machine Co. of Lima, O. While not embodying any particular departures in constructive details these locomoives are noteworthy for their total weight of 201,000 lbs., or approximately 50,000 lbs. per axle, and for the comparatively large diameter of driving wheels employed, which is 57 inches.

NEW SWITCHING LOCOMOTIVES FOR CHICAGO BELT LINE.

The tractive effort is 43,290 lbs., providing ample power for the service.

The latter on the Belt Line imposes some rather peculiar conditions which must be met in switch engine design, and prominent among these is the fact that in addition to the requisite of a locomotive of great power it must necessarily be one capable of more than the average speed for this type of locomotive. This, of course, is demanded by the congestion on the Belt Line arising from the presence of so many passenger trains of the various roads which use it. Switching operations must therefore be conducted expeditiously in order that no interference may exist with the above mentioned important traffic.

Since being placed in service these locomotives have been giving excellent satisfaction, and the railroad company is well pleased with the first-class material and workmanship embodied in their construction. The builders made quite a record with this contract, which is deserving of mention. The order was given by the railroad company on November 7, 1910, and shipment was stipulated at the rate of five locomotives during the month of February, 1911, and five during the month of March. The last of the ten engines left the Lima Works on March 30, on exact time agreed upon.

The following are the principal dimensions of these locomotives:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Switching
Fuel	Bit. Coal
Tractive power	43,290 lbs.
Weight in working order	201,000 lbs.
Weight on drivers	201,000 lbs.
Weight of engine and tender in working order	342,500 lbs.
Wheel base, driving	15 ft. 6 in.
Wheel base, engine and tender	51 ft. 4 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.64
Tractive effort × diam. drivers ÷ heating surface	823
Total heating surface ÷ grate area	72.7
Firebox heating surface ÷ total heating surface, %	5.5
Weight on drivers ÷ total heating surface	67.1
Volume both cylinders	14.62 cu. ft.
Total heating surface ÷ vol. cylinders	205
Grate area ÷ vol. cylinders	2.81
CYLINDERS.	
Kind	Simple
Diameter and stroke	24 x 28 in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving journals, main, diameter and length	10 x 13 in.
Driving journals, others, diameter and length	9½ x 13 in.
BOILER.	
Style	E. W. T.
Working pressure	180 lbs.
Outside diameter of first ring	74⅜ in.
Firebox, length and width	108 1/16 x 60¼ in.
Tubes, number and outside diameter	327—2¼ in.
Tubes, length	14 ft. 9—9/16
Heating surface, tubes	2,832.14 sq. ft.
Heating surface, firebox	165.95 sq. ft.
Heating surface, total	2,998.09 sq. ft.
Grate area	41.2 sq. ft.
TENDER.	
Water capacity	7,400 gals.
Coal capacity	11 tons

FRESNEL LENS IN RAILROAD SERVICE

The problem of getting a light that would carry around curves is one on which the railroads have been working for years, because it means so much to them from the standpoint of safety. The Fresnel lens has been worked on by numerous railroads, but there were mechanical problems connected with it they were unable to overcome. B. H. Mann, chief signal engineer of the Missouri Pacific-Iron Mountain, has been working for over a year to overcome these defects and has finally succeeded in perfecting the lamp so that it can be used on railroad trains.

Service tests have been made recently on the Hot Springs Special and on both of the through fast trains to Texas. These tests have been most satisfactory, and arrangements are now being made to have the Fresnel lens signal lamp to take the place of all other signal lamps on all trains of the system. The big advantage of the wide spread of light that the Fresnel lens gives is that in rounding a curve it spreads its rays in all directions over the land, so that trains on the other turn of the curve can plainly see it, whereas they cannot observe the light of the ordinary train signal lamp. This fact gives the Fresnel lens a great advantage in the line of safety.

PUNCTUALITY OF THE 18-HOUR SERVICE.—Since the service was inaugurated the Pennsylvania Railroad's eighteen-hour trains between New York and Chicago have made enviable records according to figures made public by the company recently. The Chicago-New York flier, No. 28, has a shade the better on the general punctuality average, but No. 29 evens things when it comes to clean monthly records. In three months it was not late a minute, and there were nine months in which it was not late more than once in each month. No. 28's best record was made during five months, in each of which it was not late more than twice. It is pointed out that in the majority of cases when these trains were late the detention was only from five to fifteen minutes.

IN HIGH SPEED STEELS, that steel containing 0.25 per cent. Vanadium has a cutting capacity almost double that of steel containing no Vanadium.

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Nov. 14	Lighting	J. A. Shaw.	Jas. Powell	Room 13, Windsor Hotel, Montreal.
Central	Nov. 10	The Distribution of Instructions and Information in Large Industries.	F. M. Whyte.	H. D. Vought	95 Liberty St., New York.
New England	Nov. 14			Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	Nov. 17	Tool Steel.	W. B. Sullivan.	H. D. Vought.	95 Liberty St., New York.
Northern	Nov. 28	Engine Failures.	G. Osguard.	C. W. Alliman	P. & L. E. R. R., Gen.. Office, Pittsburgh, Pa.
Pittsburg	Nov. 24	Swedish Steel *vs.* Others.	A. R. Roy.	F. O. Robinson	C. & O. Ry., Richmond, Va.
Richmond	Nov. 10	Election of Officers.		A. J. Merrill	218 Grant Bldg., Atlanta, Ga.
S'th'n & S. W'st'n	Nov. 16	Steel and Steel Castings.		Jos. W. Taylor	390 Old Colony Bldg., Chicago.
Western	Nov. 21			W. H. Roseveár	100 Chestnut St., Winnipeg, Man.
Western Canada	Nov. 13				

CONSERVATION OF WASTE.

CENTRAL RAILWAY CLUB.

The various factors bearing on the above timely subject were well presented in a paper read by J. F. Murphy, general storekeeper of the Lake Shore & Michigan Southern Ry., before the September meeting of this club. The author prefaced his paper by calling particular attention to the importance of the scrap dock, as from it may be obtained, through careful study, the history and record of materials, the abuses to which material is put, and the disregard for its value, as shown by material thrown into scrap which has never seen service. This portion of the paper was accorded a lively discussion and opinion was divided on the question of assorting and reclaiming stock before or after it reaches the scrap dock. Mr. Sitterly, chief inspector of the Pennsylvania Railroad, advised against the former practice on the ground that as laborers pick up scrap material it is better to allow all such to go to the dock and be sorted by competent men.

Mr. Murphy's paper practically outlined the methods in vogue for the conservation of waste on the Lake Shore and advocated that they were of general application. In considerable detail he pointed out the very great saving which can be made in the re-working or conversion of scrap material into other and useful forms. The questions of manufacturing, ordering, caring for, and disbursing of material were also briefly touched upon. This paper was of particular value in view of the discussion which it awakened, and while in connection with some of the items a difference of opinion was expressed with the author, the points brought out were of great interest to all present.

GERMAN WATERWAYS.

NEW YORK RAILWAY CLUB.

One of the most interesting papers ever read before this club was presented by Professor Edwin J. Clapp, of New York University, on the above subject at the meeting September 15, 1911. The author showed great familiarity with the general conditions appertaining to the waterways of Germany, and the paper afforded a vast fund of statistical information, many items of which have been hitherto unpublished. The unfamiliarity of the members with the subject unfortunately prevented a very extensive discussion, although the paper was listened to attentively and Professor Clapp was heartily congratulated on the elaborate research embodied in its preparation. It was pointed out that the Rhine and the Elbe are the most efficient waterways in Europe and most worthy of our attention. They exhibit a high degree of modernization in the floating stock operating on them, in the river harbors which collect and distribute their freight, and in the co-operation which exists between river and railroad. So effective is the form of water transportation described that the Elbe carries four-fifths of Hamburg's trade with that part of the interior which is reached by both waterways and railways. Commenting on the possibility of the Mississippi system ever seeing such a river traffic as the Rhine and Elbe enjoy, Professor Clapp pronounced it an interesting question for speculation, but with few signs at present of such a development. It will be rash to predict when the Mississippi will have a similar moderniation of its transportation, and a similar diversity of traffic, and the author believes that it would be less rash to assert that, if and when this modernization does come, it will best be along the lines developed by the Germans on their two great streams.

THE STREET DEPARTMENT AND SUGGESTIONS FOR TEAM TRACK DRIVEWAYS.

ST. LOUIS RAILWAY CLUB.

The opening meeting of the above club for the season of 1911-1912 was called to order by President Pfeifer at 8 P. M. on Friday, September 8, a large attendance being present. The paper of the evening was presented by Hon. J. C. Travilla, street commissioner of St. Louis, and was appreciatively received by the members. Street pavements and good roads are viewed with more interest by the railroads at the present time than ever before. The operating department is directly interested in well paved and maintained streets, as such advantages mean the handling of freight without congestion at terminals twelve months of the year. In fact, the railway companies are sending out special trains carrying experts with road machinery and equipment for the sole purpose of educating the people to build good roads, and in so doing they are the direct beneficiaries. More than one hundred lantern slides were shown illustrating city planning, street paving, with special reference to its use for team track driveways; the cleaning and maintenance of pavements, and the construction of roads.

SOME EXPERIMENTS WITH TRUCKS.

WESTERN RAILWAY CLUB.

The September meeting of this club was favored by an extremely valuable paper on the above subject by George G. Floyd, which has been liberally abstracted on page 455 of this issue. Without a doubt the tests referred to were the most elaborate ever undertaken to secure positive data on the subject of square versus loose car trucks in this or any other country, and the conclusions and deductions are of more than passing importance. These experiments were the outgrowth of a decision reached by the American Steel Foundries, in view of the evident poverty of information on the subject, to build a piece of full size track, install all scientific apparatus necessary, and determine beyond doubt, if the square truck was the better construction and how much, or to what degree it was better. Professor Endsley, of Purdue, superintended the testing plant and tests, the latter extending over a period of nearly four months during the summer of 1910. Following the reading of the paper, the discussion developed that the subject had received consideration by a number of roads, and considerable data had been gathered individually, but with no attempt at compilation. In view of the great interest exhiited by the members in the paper the motion was seconded and carried unanimously that the discussion be continued to the next meeting.

AN IMPROVED CUTTER HEAD

In the design of the new "Shimer Limited" cutter head, recently put on the market by Samuel J. Shimer & Sons, Milton, Pa., the special points or requirements imposed on these tools in modern practice were given most careful consideration, and a study of the latest type shows conclusively that the device is in every way designed to cope with them. To match flooring at the rate of 150 to 170 lineal feet per minute requires side heads of special construction. They must have great strength to stand the enormous centrifugal strains and must have a perfect balance, and the bits must all do their share of the cutting.

The new head differs from the familiar patterns in the method of attaching them to the spindles in the construction of the bit seats, and of the bit designed for faster cutting; in the greater

strength of the holding bolts, and especially in the self-centering device which clings to the spindle when drawn up and secures it firmly thereto.

The spindle gripping device is positive and effective in its purpose of holding fast to the spindle and also in centering the head for a more uniform action of the cutters. This is accomplished by having the central bore of the head tapered and having a rotatable cap and nut fitted in the upper portion. Into this bore a taper collet projects, having an upper threaded portion fitted to the rotatable nut. When the top nut is drawn up the collet contracts and binds itself firmly to he spindle. This arrangement is simple and effective and one not likely to get out of order. The various parts are made of good steel forgings and the collets are hardened and ground true to size. The entire construction of the tool is exceptionally fine in both workmanship and material.

The bit seats in these new heads carry a larger surface, and the bit chambers are of greater depth, to compensate for the new acute angle given the bits for greater relief to the parts coming in contact with the lumber. The holding bolts have been strengthened several times over by the use of a high grade steel especially made for the purpose.

Texas Lines Using Oil for Fuel.—Crude petroleum has displaced coal as fuel for locomotives upon nearly all the Texas railroads. The announcement has just been made that the Texas and Pacific will soon convert all of its locomotives into oil burners. The St. Louis Southwestern, another Gould line, will also use oil for fuel upon its Texas and Arkansas divisions, it is stated. These two roads will obtain their oil supply from the Caddo field in Louisiana. The Southern Pacific has been using oil for its locomotives since shortly after the discovery of the product at Spindle Top, Tex., about ten years ago. It now uses this fuel on all of its Texas lines, as well as on its main line between New Orleans and San Francisco. The oil supply for its eastern divisions is obtained from the California fields.

PERSONALS

George Stone has been made general foreman of the Chicago, Rock Island & Pacific Ry. at Shawnee, Okla.

H. B. McDowell has resigned as roundhouse foreman of the Chicago and Indiana Southern Ry. at Gibson, Ind.

W. H. Sholl has been appointed roundhouse foreman at Dunmore, Pa., Erie Railroad, vice E. L. Briggs, deceased.

A. G. Kantmann was on Oct. 9 appointed acting superintendent of machinery of the Nashville, Chattanooga and St. Louis Ry.

A. B. Todd has been apointed master mechanic of the Butte County R. R., succeeding James Chambers, with office at Chico, Cal.

James Shea has been promoted to be night roundhouse foreman at Bergen, N. J., Erie Railroad, succeeding John Fuller, transferred.

C. A. Gerard has been made storekeeper of the Santa Fe at Dodge City, Kan., vice O. E. Cochran, transferred to Arkansas City, Kans.

Frank A. De Wolf has been appointed acting shop superintendent of the United Railways of Havana, with headquarters at Havana, Cuba.

H. Y. Harris, general foreman of the Tampa Northern R. R., has been appointed master mechanic, his headquarters remaining at Tampa, Fla.

P. M. Hammett has been appointed superintendent of motive power of the Sandy River and Rangely Lakes R. R., with office at Portland, Me.

George C. Smith has been appointed purchasing agent of the Union Pacific Ry., with office at Omaha, Neb., succeeding J. W. Griffith, retired.

G. A. Hickok has been appointed purchasing agent of the Missouri, Kansas & Texas, with office at St. Louis, Mo., succeeding A. I. Miller, deceased.

W. R. Ryan, general car foreman of the Baltimore and Ohio R. R. at Pittsburg, Pa., has resigned to accept service with the Union R. R. in a similar capacity.

Jas. B. Hartigan, who was appointed federal boiler inspector for District No. 1 at Rutland, Vt., has declined the appointment and will remain with the Rutland Ry.

R. T. Williams has been appointed superintendent of shops at Beach Grove on the Cleveland, Cincinnati, Chicago & St. Louis Ry., succeeding M. J. McCarthy, promoted.

John Fuller, night roundhouse foreman at Bergen, N. J., on the Erie Railroad, has bceen transferred to night roundhouse foreman at Jersey City, N. J., vice W. H. Sholl, transferred.

J. F. Deems, General Superintendent of Motive Power, Rolling Stock and Machinery of New York Central Lines has resigned to become President of the Ward Equipment Company, 139 Cedar Street, New York City.

T. F. Powers, master boilermaker of the Chicago and North Western Ry. at Chadron, Neb., has been made general boiler shop foreman of the system, vice J. W. Kelly, resigned to accept service with the National Tube Co.

M. J. Fahy, general foreman of the New York, New Haven & Hartford R. R. at New Haven, Conn., has been transferred to the company's Readville, Mass., shop, exchanging positions with John Reid, who goes thence to the New Haven shop

D. T. Williams, mechanical engineer of the Philadelphia & Reading Ry., will report direct to H. D. Taylor, superintendent of motive power and rolling equipment, at Reading, Pa., and the position of superintendent of power house at the Reading terminal has been abolished.

F. C. Pickard, master mechanic of the Cincinnati, Hamilton and Dayton Railway at Indianapolis, Ind., has resigned to take a similar position with the Pere Marquette Railway, with office at Saginaw, Mich. Mr. Pickard is well known as president of the International Railway General Foremen's Association.

M. J. McCarthy, superintendent of shops of the Cleveland, Cincinnati, Chicago & St. Louis R. R., the Peoria & Eastern Ry. and the Cincinnati Northern Ry., at Beech Grove, Ind., has been appointed assistant superintendent of motive power, with headquarters at Beech Grove.

J. F. Prendergast, formerly for ten years master mechanic at the Baltimore & Ohio shops at Pittsburgh, Pa., has been appointed master mechanic of the East Broad Top Railroad & Coal Co., also of the Rockhill Iron & Coal Co., with office at Orbisonia, Pa.

CATALOGS

Pumps and Condensers.—The Dean Bros. Steam Pump Works, of Indianapolis, Ind., has issued an interesting "pony" catalog, No. 86, which illustrates a few of the standard styles and sizes of pumps and condensers. The book contains 64 pages and presents very attractively the Dean Bros. products.

Roller Bearing Car Journals.—The Standard Roller Bearing Co., of Philadelphia, Pa., has prepared in Bulletin 26 some exceedingly interesting information and valuable data on this important subject. The catalog is very handsomely illustrated with half tones and sectional drawings to scale of the standard roller bearings.

Heat Treated Axles, etc.—The Carnegie Steel Co. of Pittsburg, Pa., has recently issued a very valuable descriptive booklet on the above general subject which will be much appreciated by those interested in this process. The latter is fully described and the tables and charts showing average results of experimental tests are of exceptional value.

Vertical Boring and Turning Mills.—A very interesting leaflet has recently been issued by the Gisholt Machine Company, of Madison, Wis., illustrating views of two representative shops of Continental Europe which are making the most of the labor-saving features that have caused the Gisholt mills to be accepted by keen production experts everywhere.

Lathes.—Under this general title the R. K. Le Blond Machine Tool Co., of Cincinnati, O., has recently put out an elaborate catalog of some 150 pages dealing with the extensive line of lathes included in its output. The latter, which are fully illustrated and described, are new throughout and have been designed to meet the ever increasing demands of modern shop practice. The catalog is of especial value in its description of heavy duty lathes in which all points of construction and assemblage are minutely analyzed.

New Type Passenger Locomotive.—Bulletin No. 1011 from the American Locomotive Company describes the new "Mountain" type passenger locomotive (4-8-2) recently placed in service on the heavy grade division of the Chesapeake & Ohio Railway. This locomotive was fully described and illustrated in the October issue of the American Engineer and Railroad Journal. Its total weight exceeds any locomotive of rigid frame construction, being 239,000 on four axles, which gives an average weight per axle of nearly 60,000 lbs.

Horizontal Milling Machines.—The Fosdick Machine Tool Co., of Cincinnati, O., has a descriptive leaflet of its No. 0 horizontal boring, drilling and milling machine which enumerates the interesting features of design and construction, including also the complete specifications. In the design of this machine several prominent points of advantage will be found, including the deep bed of great rigidity, which makes the machine self-contained and a foundation unnecessary, and also insuring perfect alignment of the table with the spindle and outer support at all times.

Rotary Converters.—Descriptive Leaflet 2378, covering rotary converters for railway service, has just been issued by the Westinghouse Electric and Manufacturing Company. This is a four page leaflet, nine and a half by eleven inches, and contains quite a number of illustrations describing the various parts of rotary converters, such as armature coils, spider, equalizer connections, collector rings, commutator brush riggings, etc. Under each picture is given a short description of the method of construction of the part illustrated. One page is devoted to pictures of the rotary converters completely assembled.

Pipe Threading Dies.—In Bulletin No. 6 the National Tube Co., Pittsburgh, Pa., has compiled proper information on the subect of threading pipe which will well repay perusal. The subject is of very general interest, and although the bulletin is short, it represents some years of experience and a great many experiments. The intent is to show that there is a great deal of misinformation abroad on the question and that in many instances badly constructed dies are used which tear the pipe, and the blame is erroneously placed on the latter.

Air Compressors.—The Ingersoll-Rand Co., 11 Broadway, New York City, has issued Bulletin No. 3007, of 24 pages, descriptive of class "B. B." power driven air compressor, duplex type, with the air cylinders close coupled to the frame and a central driving wheel. The catalog shows several views of the machine in section, and gives tables of sizes and capacities. The distinctive features of this "PB" design are its massive, powerful construction and its simplicity, rugged strength, ample reserve power and unlimited capacity for hard work. The machine is readily accessible, inside and out, and is provided with flood lubrication system. Automatic control of the pressure and regulation of output to load are provided by governing devices.

New York Leather Belting Co.—On May 1 the new plant at Easton, Pa., was opened for active operations for the manufacture in America of Victor-Balata belting. For a number of years this belting has been manufactured in Germany and imported into America by the New York Leather Belting Company. While this was satisfactory as far as obtaining the great quality feature of the belting which rapidly put it in the lead of the Balata belting group, and at the head of the textile belting class, there were delays due to importation of the same and attendant duty costs, etc., and it was finally decided to erect a plant in this country. The new company is composed of German and American interests who have been connected in a business way in the Balata belting line for a number of years. The German members of the company are those of the well-known belting manufacturers, C. Vollrath & Sohn, of Blankenburgh, Germany, and C. E. Aaron and J. R. Stine, of New York, Mr. Aaron being the President of and Mr. Stine the Secretary-Treasurer of the New York Leather Belting Co., New York. The officers of the new company are as follows:—C. E. Aaron, President; J. R. Stine, Treasurer, and Edwin Vollrath, Secretary, and manager of the new plant at Easton.

NOTES

Allis-Chalmers Co.—David Van Alstyne, vice-president, has resigned and will locate in New York City.

Woodhouse Chain Works.—Wood & Van Nest have been appointed to represent the above firm in New York City, with office at 26 Cortlandt St.

Hanna Locomotive Stoker Co.—The offices of this company, Cincinnati, O., have been removed from the Second National Bank building to the Mercantile Library building.

Corrugated Bar Co.—The general offices of this company have been moved from the New National Bank of Commerce Building, St. Louis, Mo., to the Mutual Life Building, Buffalo, N. Y.

Best Manufacturing Co.—This company has recently moved its entire factory into a new plant which has been completed at Oakmont, Pa., and is said to be the most modern manufacturing plant in the United States.

Detroit Twist Drill Co.—Halsted Little, for many years associated with the sale department of Manning, Maxwell & Moore, has been appointed Eastern Sales Agent for the Detroit Twist Drill Company, with offices at 30 Church Street, Room 604.

T. H. Symington Co.—Announcement is made of the resignation of vice-president W. A. Garrett, who re-enters railroad service. Mr. Garrett was chief executive officer of the Seaboard Air Line prior to November, 1909, when he left to go to the T. H. Symington Co.

Westinghouse Air Brake Co.—C. J. Nash, who has been connected with this company for the past year as special representative in the draft gear department, has resigned to engage in the railway supply business, where he will make a specialty of draft gear attachments.

Brown Hoisting Machinery Co.—This company of Cleveland, O., announces the opening of its San Francisco office, Monadnock Bldg., with J. P. Chase as manager, and of its Chicago office in the Commercial National Bank Bldg., with A. M. Merryweather as manager.

Roberts & Schaefer Co.—This company of engineers and contractors, Chicago, Ill., has just been awarded a contract by W. J. Backes, chief engineer of the Central New England Ry., which is one of the affiliated lines of the N. Y., N. H. & H.R.R. for the design and construction of a 600 ton locomotive coaling station for installation at Maybrook, N. Y. Contract price approximately $13,000.

A. Eugene Michel.—The main offices of A. Eugene Michel and staff, advertising engineers, have been moved into the Park Row Buildng, 21 Park Row, New York, where larger space has been secured, as necessitated by constantly increasing business. Temporarily the photo re-touching and illustrating department will remain in the Hudson Terminal Buildings, but all business will be managed from the new offices.

Wood Locomotive Firebox Co.—A report supplementary to that published in the October number of the American Engineer and Railroad Journal on the condition of engine 2481 of the New York Central, which is equipped with the Wood boiler, shows that only two staybolts required removal. This examination covered the period from October, 1910, and these were the only bolts affected in that time. The record must be considered as remarkable in view of the heavy freight service in which the locomotive has been steadily engaged.

J. G. White Co.—Gano Dunn who for many years was First Vice-President and Chief Engineer of the Crocker-Wheeler Company, and is a past President of the New York Electrical Society, has been elected a Director and a Vice-President of J. G. White & Company, Inc., of New York, N. Y. Mr. Dunn has just returned from abroad, where, as a representative of the United States Government, and as President of the American Institute of Electrical Engineers, he has been attending the International Electrical Congress at Turin and the meeting of the International Electro-Technical Commission, the body that has been organized to bring about international uniformity of standards and practice in the electrical industry.

Service of Mallet Articulated Locomotives

DETAILED REPORT OF WHAT LOCOMOTIVES OF THIS COMPARATIVELY NEW TYPE ARE DOING IN ACTUAL ROAD SERVICE AND A STUDY OF THEIR ACTUAL MONEY VALUE UNDER CERTAIN CONDITIONS WHEN COMPARED WITH THE CONSOLIDATION TYPE.

In determining the actual value of any particular type of locomotive, it is necessary to take into consideration four features: 1. What are the net returns in dollars and cents of its service on the road as compared with the type previously in use? 2. Compared with this same type, what is its cost, all things being considered, while at the roundhouse, not ready for service? 3. What is the yearly cost per ton-mile, or on other similar basis for general repairs that take it out of service completely for a considerable length of time? 4. Does the net balance of saving from these three features when compared with the previous type in use equal the interest on its increased original cost?

Of course, to come to an accurate result in a study of this kind, it is necessary to have the detailed figures covering several years' service, and in the case of the Mallet, with but few exceptions, these are not available. From previous experience and data already collected from other new types, it is, however, quite possible, even after a comparatively short service, to arrive at a fairly accurate conclusion of what the net result is going to be. Also, in the case of the Mallets in particular, it is necessary to consider the fact that the design has been in the process of development, and that there has been and still continues to be an improvement in practically each new order sent out. This, then, places a study of the locomotives already in service well on the safe side, if the final conclusions are favorable.

There are at present about 500 locomotives of the Mallet type in service on different railroads in the United States, Canada and Mexico. These include practically all of the possible wheel arrangements and boiler designs, and in general are operating under quite similar conditions—usually on grades of one per cent. or greater.

While it is impossible to obtain in any considerable number of cases the money cost of both the Mallets and the type that they replace, under the different conditions mentioned above, it has been possible to get facts concerning the great majority of the locomotives in service which permit fair conclusions being drawn as to the relative value of the locomotives, all things considered, and in some cases cost data for certain features is also given.

Road Service.

Even a cursory investigation of the problem of the relative value of Mallet locomotives indicates that they, like all other new and larger types, must depend upon the first feature (road service) for sufficient saving to overcome the loss in the second and third features, and leave sufficient to equal or exceed the fourth consideration, and it is thus an investigation of the service on the road that largely solves the problem.

Tests to show the saving in coal and water on the ton-mile basis have been published in these columns and indicate that considerable economy can be expected along these lines, and an investigation of the facts given below will show the saving to be effected by increased tonnage per train or increased ton-miles per hour per locomotive.

The results from different roads reporting on this feature are detailed below.

Road No. 1.—On this road there were, at the time the report was made, 103 Mallet compound locomotives of three different classes having two different wheel arrangements. Two of these classes had a total weight of locomotive of 350,000 lbs. or more, the heaviest being nearly 370,000 lbs., and the other class weighed 228,000 lbs. The general dimensions of each are shown in Table I. The two heaviest classes of these locomotives, numbering 58, are being operated on 2.2 per cent. grades, twenty-five miles in length, having ten-degree compensated curves. The lighter class, of which there are 45 in service, are operated on various grades for various distances as shown in Table II.

These locomotives in this service superseded the consolidation type which had dimensions also shown in the accompanying Table I.

TABLE I

TYPE	2-6-6-2	2-6-6-2	2-6-8-0	2-8-0
CLASS	L-1	L-2	M-1	F-8
Total Weight	355000	288000	368700	192000
Weight on drivers	316000	250000	320000	180000
Cylinders	21½ & 33 x 32	20 & 31 x 30	23 & 35 x 32	20 x 32
Steam pressure	200	200	200	210
Superheater	No	No	Emerson	No
Feedwater Heater	No	No	Baldwin	No
Dia. Drivers	55	55	55	55
Tractive effort	*603 0	54500	81800‡	39090
Heating surface boiler	5700	3914	5070†	2767
Number in service	22	45	35	113

* As furnished by railroad company. † Includes feedwater heater, 1786 sq. ft. ‡ Baldwin formula.

An investigation of the tonnage handled, as given in Table II, shows that the Mallets haul from 21 to 92 per cent. greater tonnage than the consolidation, depending on the class.

The average speed of the Mallets over the division is from 15 to 16 miles per hour, and on the heavy grades about 8 miles per hour, the maximum speed being about 35 miles per hour, these all being practically the same as given by the consolidations with their lighter tonnage. For handling the same tonnage it will be seen that two Mallets will do about the same work as three consolidation engines, and it is about on this ratio that the power has been reduced on all these different divisions. This mere reduction in the number of trains on the road, even though they be longer and heavier, introduces a very large saving from every standpoint and one which it is difficult to estimate accurately. There is, of course, reduction in wages of engine and train crews, a saving resulting from the reduction of the dispatcher's difficulties, more reliable and profitable operation of passenger trains, reduction of switching movements, etc.

TABLE II

Class	Grade percent.	Length of Division	Tonage Mallet	Tonnage Consolidated	Increase percent.	Curves degree
M-1	2.2	25	850	525	62	10
L-1	2.2	25	800	535	52	10
L 2	1.0	195	1450	1100	32	10
L-2	1.8	18	800	650	23	10
L-2	2.2	48	700	550	27	10
L-2	1.0	129	1450	1200	21	4
L-2	.72	121	2200	1600	38	3
M-1	.4*	100	2500	1300	92	5
M-1	.3	100	7500	4000	87	5

* Has 6 miles of 1.6 per cent. grade.

As regards coal consumption, the folowing figures are reported by this road: On the .72 per cent. grade the coal consumption is 15.8 lbs. per hundred ton-miles, as compared with 18 to 20 lbs. for the consolidation type. On the 2.2 per cent. grade the consumption is 46.91 lbs. per hundred ton-miles, as compared to 41 to 54 lbs. On the 1 per cent. grades 16 lbs. is used on the Mallets, as compared with 19 lbs. for the consolidation. On the .3 per cent grade the Mallets operate on 4 lbs. of coal per hundred ton-miles, with 6 to 8 lbs. for the consolidation.

Figuring from the tests available, it is probable that the saving in water is about in the same or slightly larger proportion.

On this road the Mallets are run in both pooled and assigned service and are reported to be in every way as reliable as the consolidations which they replace.

Road No. 2.—This company has twenty-five 2-6-6-2 type Mallet locomotives in service. They have a total weight of nearly 400,000 lbs., of which about 325,000 lbs. is on drivers. The cylinders are 22 and 35 x 32 inches, and the steam pressure is 225 lbs. Total heating surface is 6,013 sq. ft., grate area 72.2 sq. ft. They have 56-inch drivers and the tractive effort is 82,000 lbs.

The service on this division was previously handled by consolidated locomotives having 22 x 32-inch cylinders and a tractive effort of 41,120 lbs.

The tonnage of the Mallets is 3,000 tons, which is handled over .58 per cent. grades, there being curves of 5 degrees on the ruling grades. A speed of from 25 to 30 miles per hour, with maximum of 40 miles per hour, is obtained.

Previous to the introduction of the Mallets the tonnage for the division was 1,500 tons, and as the traffic is dense, it has been possible to reduce the number of locomotives practically 50 per cent. and the number of crews has been reduced by about 35 per cent.

In regard to coal consumption, the consolidations burned 22.4 lbs. per hundred ton-miles, while the Mallets burn about 14.7 lbs. per hundred ton-miles, a saving of over 34 per cent. in coal consumed.

It is reported that up to this time the operation of the Mallets has been entirely satisfactory, they being fully as reliable on the road as the consolidations and one fireman is able to furnish sufficient steam for the full rated capacity.

Road No. 3.—On this road there are ten very large Mallets in service, four of which are equipped with superheaters, these are of the 0-8-8-0 type and have a total weight of 435,000 lbs. for the non-superheaters and 456,000 lbs. for the superheater engines. The cylinders in both cases are 26 and 41 x 28 inches. The drivers are 51 inches in diameter and the steam pressure is 220 lbs. They have a rated tractive effort of 105,000 lbs.

Previous to the introduction of the Mallets, service on the division was performed by the consolidation locomotives, having a total weight of 250,000 lbs., cylinders 23 x 30 inches, 57-inch drivers and 210 lbs. steam pressure, 50,580 lbs, tractive effort. These boilers had 3,968 sq. ft. heating surface with practically 100 sq. ft. grate area and burned culm.

The tonnage on the division of which this power is being operated is 2,800 tons with Mallets and was previously 2,600 tons with two consolidations. The ruling grade on the division is 1.4 per cent. and the curves are very short and numerous; for instance, there is an 8-degree curve on the 1.1 per cent. grade and a 7-degree curve on the 1.4 per cent. grade, and there are curves of 4 and 5 degrees where a train of 40 cars will be on two curves at the same time. Average speeds of about 10 miles per hour are maintained going up the hill.

In regard to coal consumption, compartive tests were made between the consolidations and the Mallets, and it was found that two consolidations burned 69.8 lbs. of coal per hundred ton-miles, while the Mallets required 39.2 lbs. of coal for identically the same work. Regularly assigned engines are used on this division and the service is reported as being as reliable now as formerly, with the great advantage of a reduction of 50 per cent. in the number of locomotives in service.

Road No. 4.—This company has 10 locomotives of the 0-6-6-0 type, having a total weight of 332,000 lbs. They have 20½ and 33 x 32-inch cylinders, 225 lbs. boiler pressure and 55-inch drivers and give a tractive effort of over 74,000 lbs., grate area 72.2 sq. ft. They are being operated over 4 per cent. grades 16 miles in length, and also continue on the descending grade for 11 miles, making the total distance run 27 miles. There are curves of 16 degrees compensated on the up grade.

This service was previously handled by consolidation locomotives having 195,000 lbs. on drivers, maximum tractive effort 43,180 lbs. These engines handled 269 tons at 8 miles per hour up hill and the Mallets draw 460 tons at an average speed of 7 miles per hour; this is an increase in tonnage of about 71 per cent., and three Mallets now take the place of five consolidations.

In regard to coal consumption, the Mallets give 4.83 train-miles to one ton of coal and the consolidations give 6.69 train-miles to one ton of coal. Figuring this at the full rated tonnage and 2,000 lbs. to the ton of coal, it gives 9 lbs. of coal per hundred ton-miles for the Mallets and 11.5 lbs. for the consolidations, a saving of about 22 per cent. [While the per cent. of saving figured in this way is probably fairly correct, the coal consumption figures are open to suspicion.—Ed.]

Concerning the service, it is reported that they are as reliable as the consolidations and that one fireman can furnish sufficient steam for the full rated capacity. Locomotives are operated by regularly assigned crews.

Road No. 5.—On this road there are 10 Mallet locomotives of the 2-6-6-2 type which have a total weight of 353,000 lbs. They are operating on one per cent. grades 12 miles in length, having 6-degree curves which are not compensated. They handle 2,400 tons at 10 miles per hour over this grade while the consolidations previously in use were given a tonnage of 1,600 lbs., showing a 50 per cent. increase in tonnage. No figures are furnished concerning the size of the consolidation locomotives and no data is available concerning the coal consumption. The locomotives are operated with regularly assigned crews wherever possible.

Road No. 6.—This company has 40 of the 2-6-6-2 type locomotives which weigh 304,300 lbs. on drivers and 370,200 lbs. total, two of the 2-8-8-2 type with 412,450 lbs. on drivers and ten of the 2-10-10-2 type with 550,000 lbs. on drivers and 616,000 lbs. total.

In regard to tonnage, the 2-6-6-2 type handle 2,250 tons on a .6 per cent. grade, the 2-10-10-2 type are given a tonnage of 1,900 which is operated over 1½ per cent. grade. The 2-8-8-2 type are used in pusher service only. These locomotives are being operated on various sections of the system and it is difficult to obtain a general comparison. The 2-6-6-2 type engine replaces the 2-6-2 type and the 2-10-10-2 type replaces the 2-10-2 type. It is reported that, generally speaking, two Mallets replace three of the former type; this, of course, depends considerably on the class of service and the density of the traffic at the point where it is operated.

On the smaller type Mallets which are coal burning, one fireman is easily able to handle them satisfactorily; the larger class, however, have been put in the oil regions and thus are also handled by one fireman. In regard to fuel saving it is stated that there is a saving in favor of the Mallets, but that definite figures are not available.

Road No. 7.—Ten Mallets of the 2-6-6-2 type, having a total weight of 527,850 lbs. with 379,650 lbs. on drivers, are in operation on one division of this road. They are operated for distances of 102 miles on a division where the ruling grade is 1¼ per cent. and are rated at 1,900 tons. On the ruling grade there are curves of 4 degrees compensated. Speeds of 11 miles per hour are averaged with maximum speed of 25 to 35 miles per hour.

This service was previously performed by consolidation locomotives and each Mallet replaces 1¾ consolidation engines. The previous tonnage was 1,175 tons. It is reported that one fireman has no difficulty in maintaining full steam pressure.

In regard to coal consumption, the Mallets consume about 400 lbs. of coal per train-mile with full tonnage over the division. This gives about 21.4 lbs. per hundred ton-miles. The consolidations used about 320 lbs. of coal per train-mile, giving 27.8 lbs. per hundred ton-miles.

Road No. 8.—This company has five locomotives of the 0-8-8-0 type which have a total weight of 376,800 lbs., cylinders 24½ and 39 x 30, 200 lbs. steam pressure and 56-inch drivers, giving a theoretical tractive effort of 85,000 lbs. It also has five of the 2-8-8-2 type with same cylinders, steam pressure and drivers. Full data for a test of both these locomotives has been given in these columns.*

* June, 1911, p. 228.

These locomotives are operated on a division which has a ruling grade of 2 per cent. four miles in length and 12-degree compensated curves. They handle a tonnage of 1,180 tons at average speed from 6 to 8 miles per hour, maximum being from 10 to 12 miles per hour. This service was previously performed by the 4-8-0 and the 2-8-0 type locomotives, the former handling 600 tons and the latter 580 tons. It will thus be seen that one Mallet practically replaces two of the other type. One fireman is capable of furnishing sufficient steam for full capacity operation and the engines are operated with regularly assigned crews.

In regard to coal consumption, the Mallets consume 27.5 lbs. per hundred ton-miles as compared with the previous consumption of 42.8 lbs. per hundred ton-miles.

It is reported that the only disadvantage of the Mallets in the service is their slower speed of operation. They run about from 6 to 8 miles per hour while the previous locomotives attained a speed of 10 miles per hour.

Road No. 9.—The Mallets on this road are of the 2-8-8-2 type, having total weight of 425,900 lbs. with 394,000 lbs. on drivers, 26 and 40 x 30-inch cylinders, 200 lbs. steam pressure and 57-inch drivers, giving a tractive effort of 94,640 lbs. They are operated about 80 miles on a 2.2 per cent. grade having 10-degree curves not compensated.

Over this division one locomotive hauls 1,000 tons at an average speed of 10 miles per hour, maximum speed attained being 22 miles per hour. This service was previously performed by consolidation locomotives, 22 x 30-inch cylinders, 180,000 lbs. on drivers which had a tonnage of 480. It will thus be seen that one Mallet replaces practically two consolidations. Since oil is used for fuel there is no difficulty in maintaining full steam pressure.

In regard to fuel consumption, the Mallets burn 14.5 gal. of oil per thousand ton-miles while the consolidations consumed 18.4 gal. of oil per thousand ton-miles, thus giving over 21 per cent. of fuel economy. Figuring 168 gal. of oil as equivalent to 2,000 lbs. of coal, this gives 17.3 lbs. of coal per hundred ton-miles for the Mallets and 21.9 for the consolidations.

These locomotives were all operated in pool service and it is reported that on the road they compare very favorably with the consolidations which they replaced.

Road No. 10.—Eleven Mallets of the 2-6-6-2 type are in operation on this road over .5 per cent. grades 22 miles in length. These locomotives have a total weight of 378,650 lbs. and are given a tonnage of 4,000, which they handle at an average speed of nearly 8 miles per hour. There are 10-degree compensated curves on the ruling grade and 14-degree curves on other parts of the division.

Previous to the introduction of the Mallets, the consolidations in use were given a tonnage of 2,400 over this division. The Mallets have been able to reduce the number of engines in service by about 40 per cent. They are operated in the pool and are reported to be about 75 per cent. as reliable as the previous service. While no data is available for the coal consumption of the consolidations, it is reported that the Mallets burn 15.9 lbs. of coal per hundred ton-miles.

Road No. 11.—The eight Mallet locomotives on this road are assigned to service on a division having a 2 per cent. grade 7 miles long, where they handle a tonnage of 1,275 at an average speed of 15 miles per hour. Each one of these engines replaced two 22 x 28-inch consolidations which were only given a tonnage of 465 on this division.

It is reported that one fireman is able to develop the full capacity of the locomotives which are run in pool service. Figures of coal consumption on either class are not available. It is reported that these engines have given first-class service up to the present time.

Road No. 12.—Four oil burners of the 2-6-6-2 type handling 2,200 lbs. over a ruling grade of .73 per cent. 1½ miles in length and having 4 degree curves are in use on this road. They make an average speed of 10 m. p. h. and maximum speed of 20 m. p. h. They replace consolidation locomotives which previously handled about half of the tonnage under the same conditions.

Road No. 13.—Twenty-five of the 2-6-6-2 type locomotives having a total weight of 390,000 lbs., 23½ and 37 x 30-inch cylinders, 57-inch drivers and 200 lbs. steam pressure, giving a maximum tractive effort of 75,000 lbs., are in service on this road. On a recent test of one of these locomotives over a division 91 miles in length having grades of .5 per cent., with the exception of 1½ miles of .67. A tonnage of 2,555 tons was handled at an average speed of 5.67 m. p.h. with coal consumption of 10.96 lbs. per hundred ton-miles.

Since this was a test run and no figures are available from regular service, owing to the short time in which the locomotives have been used, it is not possible to make a comparison with any other type of locomotive.

CONCLUSIONS ON ROAD SERVICE.

In the reports quoted above where the locomotives have been in service a sufficient length of time and in sufficient numbers to make a conclusion possible, it seems that the Mallets are equally reliable with other large locomotives in the same district. It is, of course, to be expected that upon the introduction of a new type of power, especially one so entirely different from previous designs, considerable operating difficulty may be encountered until the enginemen and trainmen become accustomed to it. It is also to be expected that inasmuch as there are twice as many parts in the running gear of these locomotives, the probability of engine failures from cases originating outside of the boiler would be considerably greater. Luckily, however, the probability of trouble from the boiler is but little more than would be the case in any other large locomotive, and since a great majority of engine failures originate from this source, there appears to be no great handicap imposed in this way. As concerns derailment, if the track is of sufficient strength, no extra trouble should be experienced. On account of the largely increased power, up to the time the engineers become skilled in handling the new locomotives, it is probable that considerable trouble will be experienced in break-in-twos.

Taking the reports as a whole, however, it does not seem that any of these features have been found serious enough to justify an expressed opinion that the service of the Mallets is not equally reliable with the locomotives previously in service.

This being the case, it is then fair to assume that the saving made by the Mallets when in operation on the road is a net saving to the railroad, so far as this part of the service is concerned, especially as it can be fairly assumed that any difficulty in dispatching, due to the longer trains, is offset by the fewer number of trains on the road for the same total amount of tonnage.

In order to obtain some idea of what the exact saving of the new type of power on the road may be, the following conditions have been assumed:

A division 150 miles long with an average grade of 1 per cent.

Consolidation locomotives of sufficient size to handle trains of 1,200 tons behind the tender over this division at an average speed of 15 miles per hour.

Mallet locomotives of sufficient size to handle 2,000-ton trains over the division at an average speed of 15 miles per hour. This is about the average increase in tonnage under these conditions as shown by the reports.

It is assumed that there are 100,000 tons of cars and lading at one end of this division to be transported direct to the other end and that the conditions are such that trains at full tonnage can be dispatched at the average rate of one per hour, and that each and every train maintains an average speed of 15 miles per hour over the division.

A coal consumption of 28 lbs. per hundred ton-miles seems to be a fair figure for the consolidation locomotives under these conditions. The reports and tests indicate that a fuel economy of about 28 per cent. in pounds of coal per hundred ton-miles can be expected from the Mallets as compared with the consolidations. This gives about 19¾ lbs. of coal per hundred ton-

miles for the Mallets and for convenience a figure of 20 lbs. is assumed.

The assumption is carried further in that a sufficient number of locomotives is assured in both cases to handle the trains under the assumed conditions, and it is further considered that 6 hours will be required for delay at the terminal before the locomotive is again ready for service in the case of the consolidation and 8 hours for the Mallets.

Other assumptions are made as follows:

Wages of engine crews for the consolidations $10.00 per trip and for the Mallets $12.00 per trip. Train crew in both cases being $15.75 per trip. Cost of engine and train supplies $2.75 per trip for consolidations and $4.75 for Mallets. The coal is assumed to cost $1.50 per ton on the tender.

Under these conditions, the cost of transporting this amount of tonnage with the two different types of locomotives is given in the following table:

	Consolidation.	Mallet.	Per cent increase or decrease.
No. of trains	83	50	39.7
Total time (1 train per hour)	93 hrs.	60 hrs.	46.3
Coal burned (total tons)	2,100	1,500	28.5
Ton miles per hour	180,000	300,000	67
Cost of engine crews	$830.	$600.	
Cost of train crews	$1,307.	$787.	
Cost of coal	$3,150.	$2,250.	
Cost of supplies	$228.	$238.	
Total cost as above	$5,515.	$3,875.	29.7
Cost of above items per ton mile	$.000368	$.000258	29.7
Cost of above items per train mile	$.44	$.516	17.2

From this it will be seen that there is a total saving of $1,640 in money and 33 hours in time in transporting this amount of tonnage complete from one end of the division to the other by the Mallets. The cost per ton-mile is reduced nearly 30 per cent. and the ton-miles per hour is increased about 67 per cent.

The number of locomotives engaged in handling the freight is the same in both cases, the exact number, of course, depending upon the rapidity with which they are returned to the other end of the division.

Figuring from this data under an assumed condition of 20,000 ton-miles per hour per locomotive (average for twenty-four hours) and considering the difference in terminal delay, it appears that there is a saving of $41.66 per locomotive per day.

It will be noted that no consideration is given the return trip, as it is probable that on down grade work there will be practically no difference in the two cases if the same average speed is attained. As a general proposition is is believed that the consolidation will give a higher speed and by thus being under full tonnage a greater percentage of the time the above estimated saving will be somewhat reduced.

MAINTENANCE.

This feature consists of two parts which are generally called running repairs and shop repairs. The first including all work which does not take the locomotive out of service for any extended length of time, and in this discussion will be considered as including cleaning, adjustments and renewal of minor parts. For the purpose of investigating the matter in more detail, it will be divided into two parts: first, expense of handling and cleaning, and second, adjustments and renewals necessitated by ordinary wear and tear while in service.

As concerns handling, it probably costs little or no more so far as taking coal, water and sand and in the movement of the locomotive from the yard to the cinder pit is concerned. At the cinder pit the expense will be somewhat greater due to the larger size of the locomotive, both as regards the cleaning of the fires, ash pan and front end and also the amount of room occupied on the pit. From this point into the roundhouse the expense will be no greater for these locomotives than for a consolidation if the turntable is of a proper size. If it is not, and the locomotives have to be turned on a wye and stored in temporary structures, then, of course, the expense will run up very materially. In this discussion, however, it will be considered that the facilities are suited to this class of power and that the locomotive can be handled on the turntable without removing its tender, and that it can be run far enough into the house to permit the closing of the doors. Under these conditions, it seems fair to assume that from leaving of its train to the arrival at the pit in the roundhouse, the expense of the Mallets will be a little higher, possibly 5 per cent., than would the consolidations in size assumed above.

After arriving on the pit or while on the inspection pit outside, if this is provided, the amount of inspection is practically double that of an ordinary simple locomotive and will cost at least twice as much if properly done. Wiping the locomotive comes under the same class and will be at least twice as expensive.

The next consideration being the one which forms the greater proportion of terminal expense, is the matter of repairs and adjustments. These, of course, are the direct result of service on the road or misuse on the cinder pit or storage yard.

As concerns the difficulties which have been experienced by this class of locomotive in road service the following are reported:

Road No. 1.—No trouble with ball joints after roundhouse force became accustomed to handling the work. Flange wear is less than on consolidation locomotives. Principal difficulties with the type have been in the case of one class fitted with feed water heaters where considerable trouble has been incurred by the pitting of the flues in the heater. On this road the regular roundhouse force takes care of the work on the Mallets.

Road No. 2.—No trouble has been found with keeping the ball joints tight. Flange lubricators are not used and the flange wear seems to be less than on the consolidations. The regular roundhouse force takes care of the work on these locomotives and no features of the design have given any particular trouble.

Road No. 3.—On this road a special gang has been organized to do all mechanical work on the Mallet locomotives and these men have been trained to be specialists on this class of power, they, however, working on other locomotives when there are no Mallets in the house. No special trouble has been given by the ball joints or in fact by any other part of the locomotives. Flange lubricators are used which permit the engines to go 31,000 to 32,000 miles between tire turnings.

Road No. 4.—There has been practically no trouble with the ball joints leaking. There has been considerable trouble with flange wear although the flanges are lubricated with water. This road has also had considerable trouble with the casting that forms the articulated joint because of the bolts working loose. A great deal of trouble has been incurred by the tires wearing oblong and it has been necessary to change tires after the locomotives have made about 15,000 miles. Difficulty has also been found in various smaller matters which, however, are not peculiar to this particular design. The regular roundhouse takes care of the work on these engines.

Road No. 5.—Considerable difficulty has been found on this road in keeping the ball joints tight, and while the locomotives have not been in service any great length of time, it has not been found so far that the flange wear is any greater than on other power. A special gang has been organized in the roundhouse for taking care of the Mallets.

Road No. 6.—The experience of this road is probably the same as that of many others, that considerable difficulty was found in keeping the ball joints tight at first, but after the roundhouse force became accustomed to the work everything was all right. Flange lubricators are used and it does not appear that the flange wear is any greater on these classes. The work in the roundhouse is handled by the regular force and no troubles peculiar to the design are reported other than the one just mentioned.

Road No. 7.—In this case the regular roundhouse force takes care of all the work on the Mallets and considerable difficulty is reported in keeping the ball joints tight. The flange wear is stated to be no greater than than on the consolidation locomotives with the exception of the front drivers of the low pressure unit. Considerable difficulty has been reported in keeping the steam pipes in the combustion chamber tight and in the pitting of the flues in the feed water heater which requires their frequent renewal. It is stated that after these locomoives have

been on the side track for some time, they do not steam as freely as other types when first starting out.

Road No. 8.—A special gang is organized for taking care of the work on the Mallet locomotives so far as possible. It is reported that trouble has been given by leaky ball joints, but that the flange wear does not seem to be any greater than on other classes. Other features which have given trouble are high pressure steam pipes leaking, the rod brass wear is excessive and saddle bolts work loose. It is also reported that the locomotives are very rough riding.

Road No. 9.—Careful attention has eliminated the trouble of leaky ball joints, which was practically all of the trouble peculiar to the design that was found. Flange lubricators are used and the wear is not excessive. The regular roundhouse force takes care of the repairs.

Road No. 10.—Trouble has been found here with keeping the ball joints tight, but the flange wear is not as great on these locomotives as on others. The regular roundhouse force maintain the repairs and no difficulty peculiar to the design other than the points mentioned is evident.

Road No. 11.—In this case the power has been in service a comparatively short length of time and no difficulty has been found in keeping the bolt joints tight, but the evidence is that the flange wear will be greater than on the power replaced. The regular roundhouse force take care of the work and no special trouble has been reported.

Road No. 12.—On this road it is reported that no feature peculiar to the design has given any trouble, the ball joints have never been touched and remain tight. Tire wear is bad on the back group of drivers, but this is attributed to the special conditions under which these locomotives were operated. The regular roundhouse force maintain the repairs.

Road No. 14.—No trouble of any kind that can be attributed to the design has been reported by this road. No special gangs are organized for maintaining the power and the flange wear seems to be the same as on other types.

GENERAL REPAIRS.

In a general way the same conditions affect the cost in the shop as in the case of the running repairs. If the Mallets have two sets of four pairs of drivers, the repairs on the running gear will be more than double what they would on a consolidation, due to the additional work required by the steam and exhaust pipes, the articulated joint and the intercepting or bye-pass valve. Boiler repairs, however, will increase in about the ratio of the increased heating surface for a saturated steam engine, possibly 35 to 40 per cent. It would thus seem taken all together, so far as labor and material are concerned, that the general repairs on a Mallet locomotive would be about double that of consolidation.

In addition to the cost of labor and material, however, consideration of the length of time out of service should also be included. In some shops there will probably be very little difference in this, but in others it is probable that repairs on the Mallet will take up to 50 per cent. longer than on consolidation, the matter, of course, depending altogether on the size, organization and operation of the shop. If the surcharges of the shop are charged to the locomotives this increased time required for repairs will be an item of considerable importance, independent of the elimination of the daily saving the power could give while in service.

As to the frequency of general repairs, any difference between the two types of locomotives will, of course, depend entirely upon the thoroughness of the running repairs. In view of the assumed increased terminal delay of 33 per cent. allowed the Mallet, it will probably be fair to consider that both types will make the same mileage before general repairs, and this feature will not be given consideration.

CONCLUSIONS ON REPAIR COST.

On running repairs taken as a whole, it would appear from the reports that comparatively little trouble has been found in connection with the features peculiar to this type of locomotive. While in several cases difficulty is reported with the ball joints leaking, it is evident from the experience of others with the same design of joint that this will be largely corrected with the training of the repair force. Flange wear with very few exceptions does not seem to be excessive. It appears that the feed water heaters where applied have been a source of trouble in some cases due to the pitting of the flues. In cases where feed water heaters are not applied, it is evident from the reports that no more trouble is given by the boilers on the Mallets than on other large locomotives in the same district, and it is probable that the expense of maintaining the boilers at the roundhouse will be but little more than on other locomotives.

The maintenance of the running gear, however, comes entirely in another class, and there is no doubt but what in this particular these locomotives will cost over twice as much as simple engines, the expense being increased not only by more than double the number of parts to take care of, but also by the greater weight of the locomotive, its somewhat complicated arrangement and the usual inadequacy of the terminal facilities for taking care of it.

From this discussion it would appear to be amply on the safe side to assume that the Mallet locomotive will cost twice as much for strictly running repairs as the consolidation which it replaces. In all probability, in the majority of cases, this increased expense will be about the ratio of the increased tonnage handled per locomotive. For general repairs it is probable that the Mallet will cost more than twice as much as the consolidation.

The cost of repairs varies greatly at different points and is so dependent upon local conditions, such as quality of fuel and water, frequency of curves, class of workmen, presence of suitable facilities and design of the locomotive, that it is difficult to assume a figure which can be considered representative. Since it is the cost of these features which will determine very largely if the Mallet is going to be a paying proposition, careful investigation on this point will be required in each particular case.

From an investigation of such figures as are available for the cost of repairs under conditions similar to those assumed, it appears that a cost including both general and running repairs of 10 cents per locomotive-mile for a heavy consolidation locomotive is within reason. On this basis, it would appear that the Mallet would cost 22 cents per locomotive-mile.

Applying the conditions as assumed above and making a further assumption that the consolidation locomotive will make the run down hill at an average rate of 30 miles per hour, or 5 hours to the trip, having the same terminal delay at both ends, but that the Mallet are only to attain an average speed of 25 miles per hour and require 6 hours per trip, also have the same terminal delay at both ends, the following results are obtained.

Percentage of time in service on the road, consolidation 56 per cent., Mallets 50 per cent.; average mileage for 24 hours, 257 for the consolidation and 225 for the Mallets. Average cost of repairs per 24 hours for consolidation $25.70 and for the Mallets $49.50, an increase of $13.80 per 24 hours.

Subtracting this from the saving of $41.66 per day shown from the actual road service, it leaves a net saving for the locomotive of nearly $28.00 per day per locomotive under the assumed conditions. From this, however, should be subtracted an amount covering the loss by the increased time in the shop. This will be amply covered by $3.00 per day, leaving a net saving of $25.00 per day per locomotive when working under the assumed conditions.

Since the locations are very rare where a constant tonnage of this amount is available throughout the whole year, a percentage will have to be determined in each case, due to the decreased saving given by the Mallets when not under full tonnage and when the operation does not give the daily mileage assumed, also a reduction due to the time that both locomotives are in the shop.

For the purpose of discussion, we will assume that an average saving of this amount can be attained on 200 days in the year, giving a yearly saving of $5,000 per locomotive.

From this must be taken the interest on the increased cost of the locomotive. As compared with a consolidation locomotive capable of performing the work outlined, the Mallet would cost approximately twice as much. For discussion, the cost of the consolidation can be assumed to be about $17,000, and at five per cent. this gives a yearly capital charge of $850, which subtracted from the $5,000 obtained as the yearly saving, gives $4,150 per locomotive per year direct saving from train operation.

In view of the tests on the New York Central Lines, which are given elsewhere in this issue, it is evident that the assumptions for economy or increased capacity made herein, are very conservative. The figures given will probably apply as a fair average for a saturated steam Mallet locomotive, but it is evident that the saving will be decidedly greater when the superheater and brick arch are applied. This will be especially noticeable in the number of ton-miles per hour, since it is evident from the tests that speeds up to 30 miles per hour can be attained with nearly full tonnage.

While this whole discussion has been based on the cost of handling a certain definite amount of tonnage, this seeming to be the most logical way of treating the subject, it is probable that in most cases the economy of the locomotive will be appreciated most because of its ability to increase the capacity of a certain division, and instead of having fewer trains, it would be a case of the same number of trains with a large increase in tonnage. This is clearly demonstrated on the Pennsylvania division of the New York Central Lines where 1,400 cars are now handled by 26 Mallet locomotives while previously but 1,000 cars could be handled by 60 consolidation locomotives.

OXY-ACETYLENE WELDING*

It will not be necessary in this connection to discuss the kind of apparatus to be used, whether oxygen under high pressure or low pressure is the most economical; whether the tank storage system or retort method of handling and manufacturing is the best, or whether it is better to have the apparatus stationary and gases piped to the work or portable, to be taken whenever wanted. We have used both types and have our own ideas as to which is best. I want to state briefly that when beginning to use whichever system is decided on, there will be lots of disappointment in store for those of you who think you can get immediate results, particularly so if you are developing your own operator.

We began in an humble way about 18 months ago and thought inside of a week or two we would be welding up flue sheets, putting patches in fire-boxes, repairing castings and a hundred other things our friends had told us could be done so easily, but apparently nothing went right; a crack would be welded in one place only to open up again or start another in a different location. We had some comfort in the fact that even the so-called experts fell down, one case in particular being fresh in mind: A casting was broken which we desired to have repaired at once and, having oxygen and acetylene on the ground, thought it would be a good opportunity to let some of the people (who were so anxious to show us how it could be done) have a chance at it, which we did, and with miserable results, the operator claiming the iron was so poor that he could not get anything suitable to work on. After this, some of our men felt very discouraged at the results obtained and you could hear them saying "I told you so," but others were nearly as optimistic as I was, although after over four months' trials and tribulations, if a vote had been taken at that time, it would have been overwhelming in favor of dropping the whole thing. Finally, however, we were able to weld up some unimportant castings which gave us fresh courage. As we were having considerable trouble with cracked flue sheet bridges on certain engines, thought it would be a good thing if we could weld them up and, before trying it on a flue sheet in place, we got an old one and experimented for days with it, sometimes having more cracks at night than we started with it in the morning; at last we appeared to have solved the difficulty and started on a flue sheet in an engine, and all we had learned on the flue sheet that could expand and contract without having anything to prevent it, had to be learned over again when the sheet was held rigidly in place without an opportunity to move in any direction. We were, after considerable experimenting, at last able to handle this kind of work in a satisfactory manner, and all having experience with boiler work will appreciate what it means to be able to do a job of this kind on a flue sheet that is otherwise in good condition.

One morning we were confronted with a rush job which, if successful, would mean a good deal to us. A superheater locomotive was in the shops with a cast iron steam pipe cracked for a distance of 14 inches. Unfortunately, as it appeared at the time, we did not have a new steam pipe nor a pattern to make one, and the engine was badly needed, as engines generally are, especially when it looks as if you cannot get them. Fortunately, we had the oxy-acetylene apparatus, and after a council of war it was decided to try and weld up the steam pipe, although most of our men thought it could not be done satisfactorily. The attempt, however, was made, and much to our surprise a first-class job was the result. This gave us confidence and other jobs were undertaken, some of which turned out well and others were failures. At about this time we got hold of an operator who used his head while doing his work, and after that it was comparatively easy; nothing was too complicated to tackle and we are able to successfully weld fireboxes, apply patches, weld in half side sheets, repair broken cylinders, weld broken driving wheel spokes, built up worn parts on castings, air reservoirs, etc., repair broken castings of all kinds, so that now we cannot keep house without it. A saving of from $1,200 to $1,500 can easily be effected per month in a shop like ours by repairing things that otherwise would have found their way into the scrap; this amount simply covers the actual saving and does not in any way take into consideration the value of the time an engine or machine may be out of service.

*Abstracts from a paper by H. T. Bentley before the Western Ry. Club.

INCREASED USE OF OIL ON RAILROADS

An interesting feature shown in the report on petroleum for 1910, by the United States Geological Survey, now in preparation, is the statement of the extent to which oil enters into railroad transportation. The total length of railroad line operated by the use of fuel oil in 1910 was 21,075 miles, a trackage equivalent to that of practically five transcontinental lines stretching across the United States from ocean to ocean. Some of the lines that use oil, however, also use coal. The number of barrels of fuel oil—of 42 gallons each—consumed by the railroads of the country in 1910 is stated to have been 24,526,883. This included 768,762 barrels used by the railroads as fuel otherwise than in locomotives. The total number of miles run by oil-burning engines in 1910 was 88,318,947.

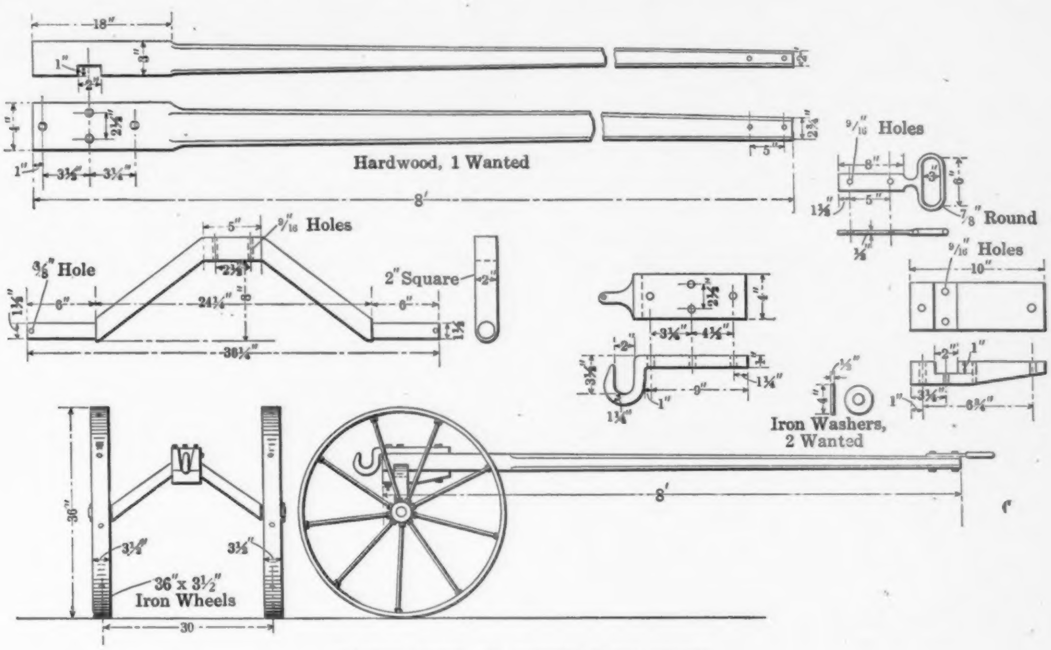
Concrete Poles are made in Germany of a hollow reinforcement of wire filled with a composition of cement, sand and asbestos, which is dried by being rotated from eight to ten minutes at 1,000 to 1,500 revs. per min. The centrifugal force exerted during this operation is said to impart density and strength to the concrete. The maximum dimensions of these poles, of which over 5,000 have been used in Dresden, Prague and Leipzig, are 46 ft. in length by 16 in. diameter.

A French Alloy, especially good for coating sheet iron for constructive purposes, consists of zinc 5.5, lead 23.5, tin 71. If it is a metal of a fine white color and high luster, 5 to 10 per cent. of bismuth may be added, making a composition of tin 90 to 95, bismuth 10 to 15. An admixture of one-half, or at most 1½, per cent. of iron in tin greatly increases its hardness and durability.

TWO USEFUL SPECIAL DEVICES

Charles Markel.*

Although the design and construction of hand trucks for moving weighty parts from place to place about locomotive terminals are both practically as numerous and varied as the individual shops themselves, it is nevertheless believed that the one herewith illustrated will prove of interest. It is intended for the easy carriage of pistons, main and side rods, driving boxes, etc.; in fact, anything portable which the distance between the hook and the floor will permit.



HANDY SHOP OR ROUNDHOUSE TRUCK.

As the drawing clearly indicates, the predominant characteristic of this arrangement is extreme simplicity. With the exception of the two 36 by $3\frac{1}{2}$-in. iron wheels the parts are readily within the resources of any shop, and the cost of assemblage is inconsequential. The very great leverage exerted through the 8-ft. handle, in view of the proximity of the weight hook to the fulcrum point, permits of very heavy parts being picked up with the greatest ease. The capacity of this truck will allow it to take two large steam pipes at one load, if necessary, four guide bars, or in fact any erecting shop combination which in many cases are trucked singly.

From the labor-saving viewpoint alone these trucks are of great value in roundhouse work, and should be considered part of the equipment of that department. Ordinarily, unless the load is excessive, one man can readily take care of it, the advantage of this being manifest in the fact that the drop pit gang is not temporarily weakened by the absence of two or three helpers which without the device would be required to get the driving boxes or parts to be repaired into the machine shop.

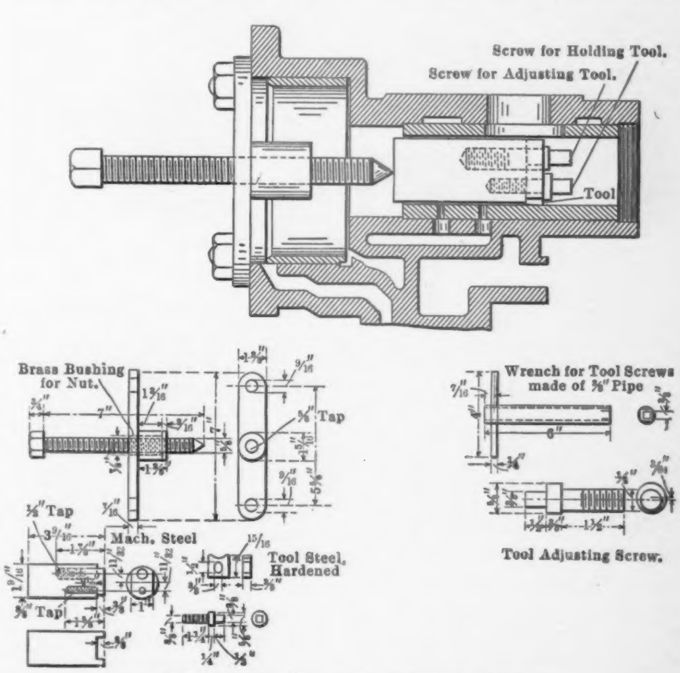
The facing tool for distributing valve, E-T equipment, is a very clever device and merits special attention. It is intended for use in reducing or lowering the face of the bushing on the distributing valve. It will be recalled that this brass bushing has a flat seat 5 in. long, and that as the valve only travels on this seat 3 in., a shoulder is left at the end of the valve travel. Consequently when this seat requires facing, which is of not infrequent occurrence, it must be faced and scraped for the full five inches. The object of the tool shown herewith is to remove this shoulder and also any amount of metal below the surface of the original seat. The amount recommended in the last named procedure is 1/32 in., which, experience has demonstrated, will last for some time.

The tool is simply a round piece of machine steel, and the details may be readily understood from the drawing. It is turned up to fit the bore of the bushing, and on one end it is planed to fit the tool steel cutter, the latter being held in place by a $\frac{3}{8}$-in. bolt. The tool is fed to its work by a $\frac{1}{2}$-in. screw bolt, which has an eccentric shoulder to engage in a groove at the top of the tool or cutter. The latter is then forced by the screw and yoke as illustrated.

This is regarded as an indispensable special device to the air brake repair department, doing its work quickly and perfectly, and with a minimum of the time and labor formerly expended.

* Foreman, Clinton Shop, Chicago & North Western Ry.

A Noted Expert in Boiler Design has expressed the opinion that it is far better to make the butt-straps of a boiler narrow, and correct the weaknesses in the seam by making the butt-straps thick, and thus prevent cracking and similar mishaps with riveted joints.



FACING TOOL FOR DISTRIBUTING VALVE.

The Highest Bridge in the World is that over the Sionle gorge, between Montloon and Clermont-Ferrand, France, its height being 450 feet.

New Electrical System of Cab Signalling

THE NORTH EASTERN RY. OF ENGLAND HAS RECENTLY INTRODUCED ON ONE OF ITS BRANCHES THE RAVEN ELECTRICAL CAB SIGNAL WHICH HAS APPARENTLY SOLVED THE PROBLEM OF EXPEDITING TRAIN MOVEMENT WHEN THROUGH FOG THE REGULAR FIXED SIGNALS CANNOT BE READILY OBSERVED.

Cab-signaling has not been viewed with any particular favor on railroads of this country for several good and sufficient reasons, prominent among which are that it admittedly necessitates extremely delicate appliances in the face of quite stringent requirements, and because the scheme of railroading as here practised is presumed to achieve better results by not depriving the engineer or any other employee entirely of the initiative.

The subject is nevertheless an interesting one and is receiving

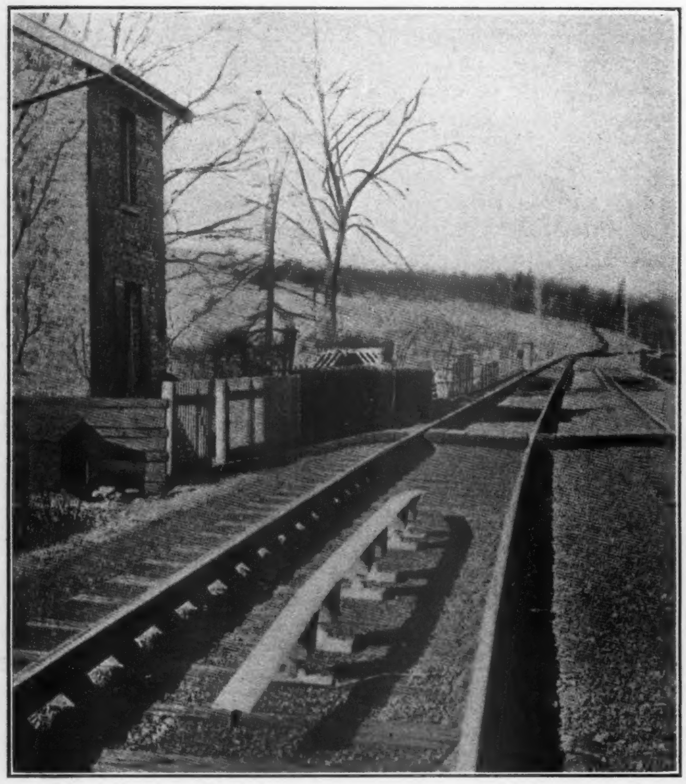


FIG. 1.

at this time considerable attention on foreign roads, particularly on those of England, where at least several experimental installations have been made. As, of course, is well known, that country in certain seasons of the year experiences fog to a degree unknown here and this naturally endows a successful form of cab-signaling with greater value than could be associated with it under the more favorable weather conditions prevailing in the United States. In times of heavy fog in England it becomes necessary to put on additional signalmen to facilitate the train movement, and even then the latter is frequently very seriously interfered with. This no doubt explains why so much attention is being given to the development of a system through which the positions of the fixed signals may be faithfully reproduced in miniature in the engine cab, thus permitting schedule speed to be at least approximately maintained.

According to the *Railway Engineer,* of London, such a system, known as the Raven Electrical Cab Signal, has been installed on the Richmond Branch of the North Eastern Railway. All the engines working on that branch have been equipped, and after satisfactory tests, the system was formally opened on August 14th last, and fog-signalmen were dispensed with. Although embodying what might be considered features of complexity, this arrangement presents nevertheless an interesting study as indicative of the progress which has been made in the art of cab-signaling.

At every signal tower there are provided on each line at least four bars similar to that illustrated in Fig. 1. One of these is placed about 150 yards in the rear of the distant signal, a second is fixed in the rear of but close to the distant, and a third of similar construction is located midway between the distant and home signals, while the fourth is just in the rear of the home signal. When there is a starting signal a fifth bar is also provided in the rear of it. These bars are T-section steel and are supported by wooden blocks laid on porcelain insulators carried on the sleepers. At stop signals the bars are about 60 ft. in length, while the other bars are about 30 ft. long. Fig. 2 is the engine apparatus in which it will be seen that in the middle is a shoe carried by links. To the middle of the shoe is connected a lever coupled at the other end to a switch working in the switch-box seen on the left in Fig. 2. The shoe is kept down normally by a spring above it. On either side of the apparatus are metallic brushes carried by the same frame as the shoe and the frame, shoe and brushes are further kept down

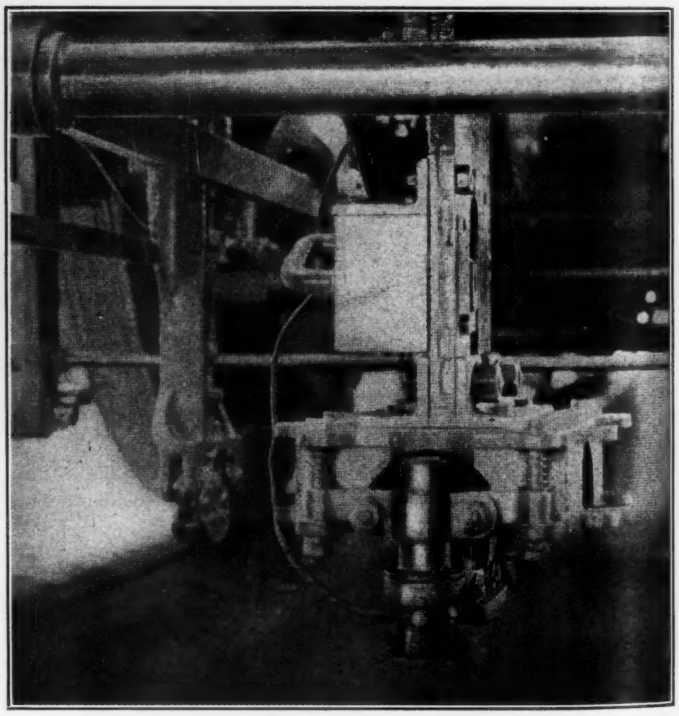


FIG. 2.

by a spring at each of the four corners, two of which are shown in Fig. 2. The contact making apparatus is insulated from the engine frame.

In the engine cab, Fig. 3, on the left, is a visible indication, and on the right a bell and switch. Below the bell by the side of the reverse lever is a battery box. An enlarged view of the indicator is given in Fig. 4. The miniature arm gives two indications—danger and clear. The route indicator below shows whether, at a junction, the road is set to the left or right at places other than junctions the indicator inclines to the left and is deflected for every signal.

The operation of the system is as follows: The first bar

passed over sets the engine apparatus, raises the bar and starts the bell ringing, whether the line be clear or not. In 150 yards or so the second bar is reached. While traveling over this bar the bell ceases, but should the line not be clear the bell starts again as soon as the shoe is off the bar. If, however, the signals are clear the bell does not resume and the miniature arm falls to the safety or proceed position, and the route indicator is deflected. Should, however, the signals still be in the danger position, the engineer would continue slowly on his way, the bell ringing all the while, until he got to the home signal. He would know his position by the bell ceasing when on the bar at the signal, and if the miniature arm still remained at danger he would come to a stop, taking care that his engine was on the bar. Should he overrun the latter the bell would start again, and would not stop until he backed up. If, however, the home and starting signals had meanwhile been lowered the bell would not only cease ringing at the home signal bar, but the miniature arm would go to the safety position and the indicator be deflected.

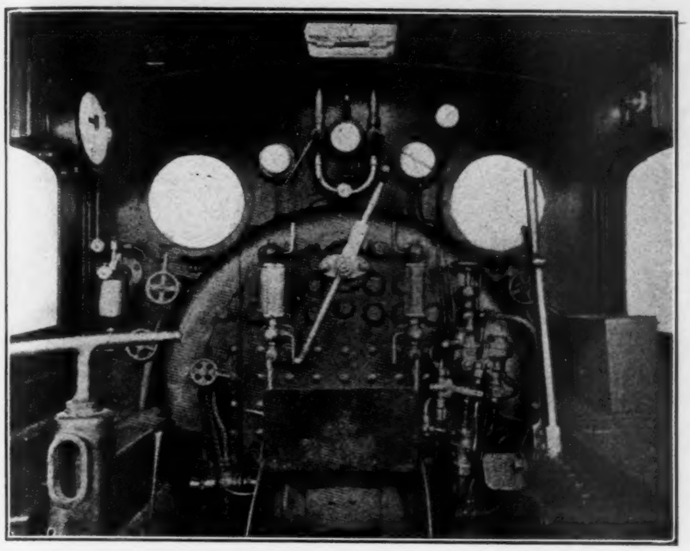


FIG. 3.

Another condition is, of course, possible, which is that the train may be delayed waiting for the section ahead to be cleared. If so, the home signal would be lowered after the train had been brought to a stand and then it be allowed to move forward to the starting signal. The arrangement is, however, such that the bell must ring—except when the engine is on a bar—and the miniature arm must remain up as long as a train is between the first bar and the starting signal, unless both the home and starting signals are clear. In this condition the following would be the procedure:

After the towerman has lowered his home signal he presses a tapper key specially provided, and this momentarily cuts in the circuit to the miniature arm and causes the arm to move up and down. This is a "calling on" signal, and when the engineer receives it he may pull slowly forward to the home signal, but the bell starts ringing again as soon as the bar is left. The arm remains up, and this continues until the starting signal is reached. There the bar is also 60 ft. long. The bell ceases and the engineer looks at the miniature arm. If it remains up the signal is still at danger and he stops, but if the arm falls and the route indicator is deflected he goes ahead and no change is made until the train approaches the next distant signal.

The electrical equipment is on the closed-circuit principle. Power is necessary to stop the bell, also to lower the miniature arm so that any electrical failure leads to the bell not ceasing, and the arm is maintained in the danger position by a continuous current. The indicator when deflected is locked to left or right, and every time a "clear" bar is passed a slight movement of the indicator is given as the brushes pass over the bar.

In the instructions to engineers they are advised that the electric signals are supplementary to, and not in substitution of, the outdoor signals. It may, however, be mentioned that should the system prove to be the success it is anticipated the distant signals on the Richmond branch, at all events, will be dispensed with. The engineers are required to make a report after each trip of the behavior of the apparatus. For the towermen the only addition to the signaling is the tapper-key for "calling on" the engineer when he has to pull up to the starting signal. The sectionmen have instructions to keep the bars clear of frost and snow, and during frosty weather to wipe the upper surface with a cloth steeped in paraffin oil.

Thus is briefly described what is apparently an efficient cab-signaling installation and its subsequent performance will no doubt be awaited with interest. As above outlined, the scheme in general carries a particular appeal where the ordinary signals cannot be readily observed due to peculiar climatic conditions, but the fact must remain that the original cost of such an arrangement must be very great and its maintenance an expenditure scarcely warranted by the benefits derived.

In general all apparatus for cab-signaling should be simple, positive, easily maintained, easily replaced, and yet able to stand the rough and tumble to be found in railway work. This latter means exposure to dust, dirt, rough usage, and all sorts of climatic conditions. Above all, the apparatus must be reliable and, in the rare event of failure, must so face that the danger signal is shown and must be observed.

SINCE 1900 THE PENNSYLVANIA RAILROAD SYSTEM has avoided grade crossings in all new construction work and has been doing away with those already in existence as rapidly as possible. Many millions have been spent in this work, with the result that 673 grade crossings were eliminated from the Lines East of Pittsburgh between January 1st, 1900, and September 1st, 1909.

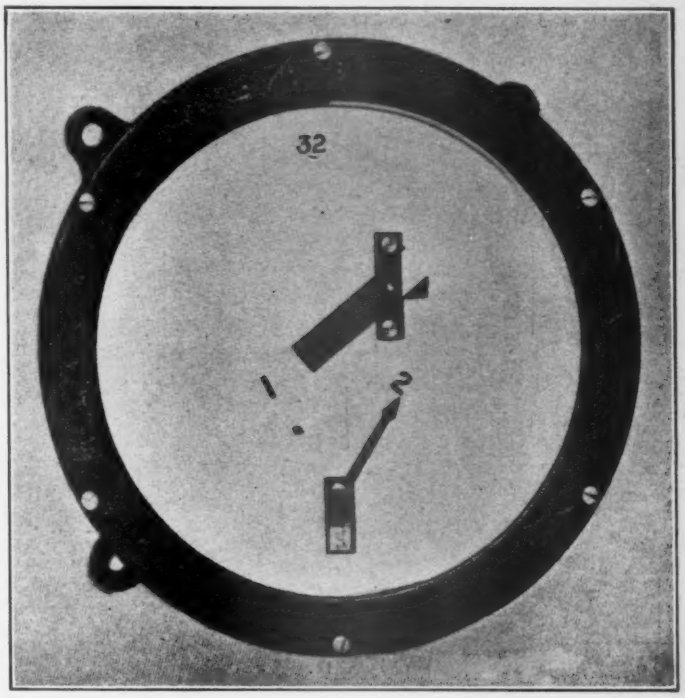
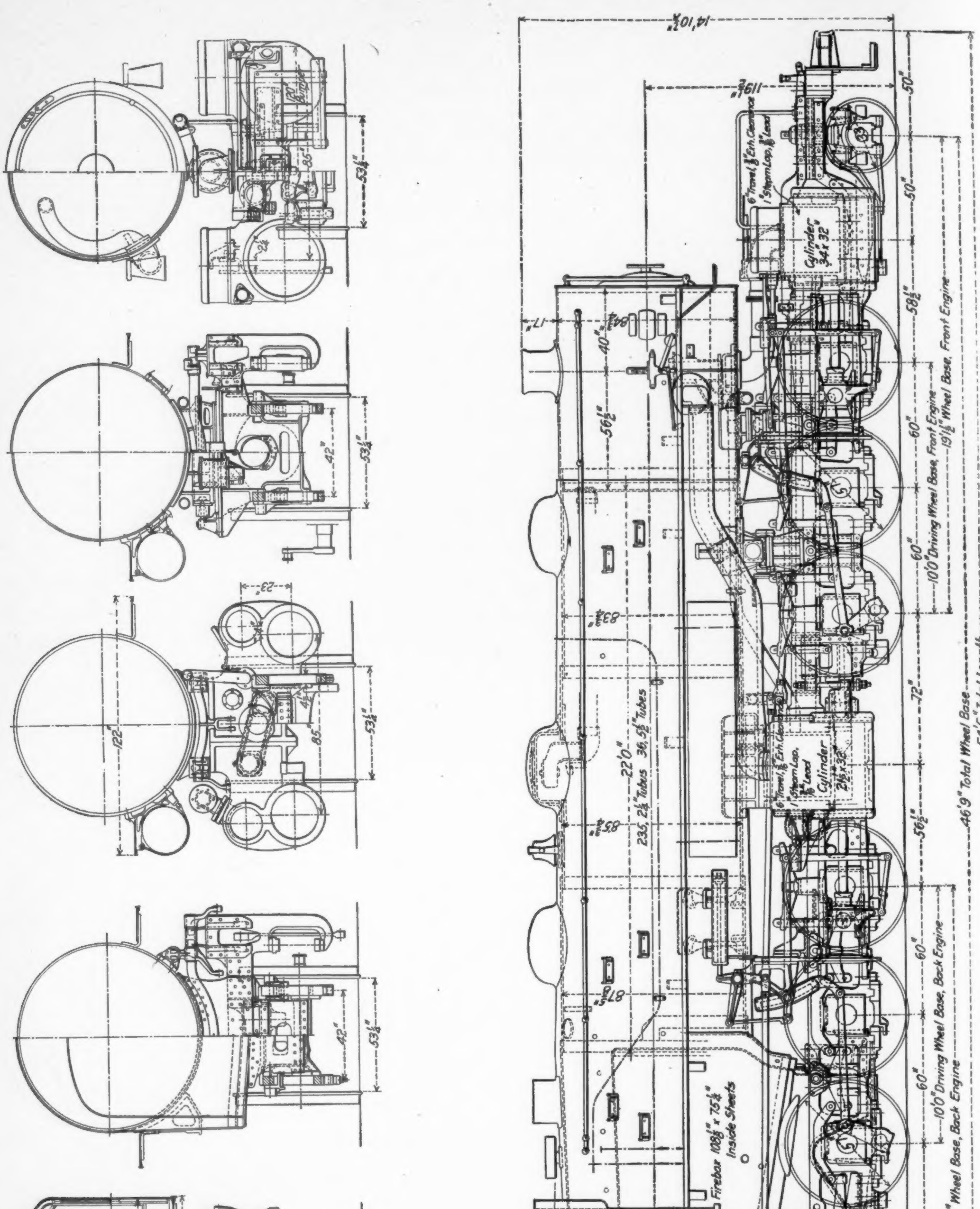


FIG. 4.

ON THE LINE OF THE CANADIAN PACIFIC telephone conversation was carried on between Montreal and Fort William, 995 miles, over a No. 9 iron telegraph wire, grounded; and, according to the reports, the experiment was a marked success. The instruments used are of a new design, invented by David H. Wilson, of Chicago. The apparatus is said to be well adapted to use on composite circuits—telegraph and telephone.



DESIGN OF 2-6-6-2 TYPE LOCOMOTIVE BASED ON RESULTS OF ELABORATE SERIES OF TESTS ON THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL.

Test of a Mallet Locomotive Equipped With Superheater and Brick Arch

NEW YORK CENTRAL AND HUDSON RIVER RAILROAD.

On the Pennsylvania division of the New York Central and Hudson River Railroad, a large volume of slow freight traffic is handled over a single track having fairly heavy grades and numerous curves. The motive power has been heretofore largely of the consolidation type designated as class G-6-G which have a total weight of 236,000 lbs. and a tractive effort of 45,700 lbs. There were 60 locomotives of the class in service, of which 31 were used for pulling trains and the remainder for pusher service.

Traffic became so dense on the division that the maximum capacity of the single track was practically reached, and if any increased business was to be handled it would be necessary to either double track or increase the weight of the trains by the adoption of heavier motive power.

Early in 1910 the American Locomotive Co. designed and built a Mallet compound locomotive for the Boston and Albany Railroad which it was proposed to use on a certain section of that line,* and it seemed advisable to the management to investigate the possibilities of this type of locomotive in solving the problem on the Pennsylvania division. It was therefore transferred to that point and careful tests carried out on both the Mallet and the consolidation.

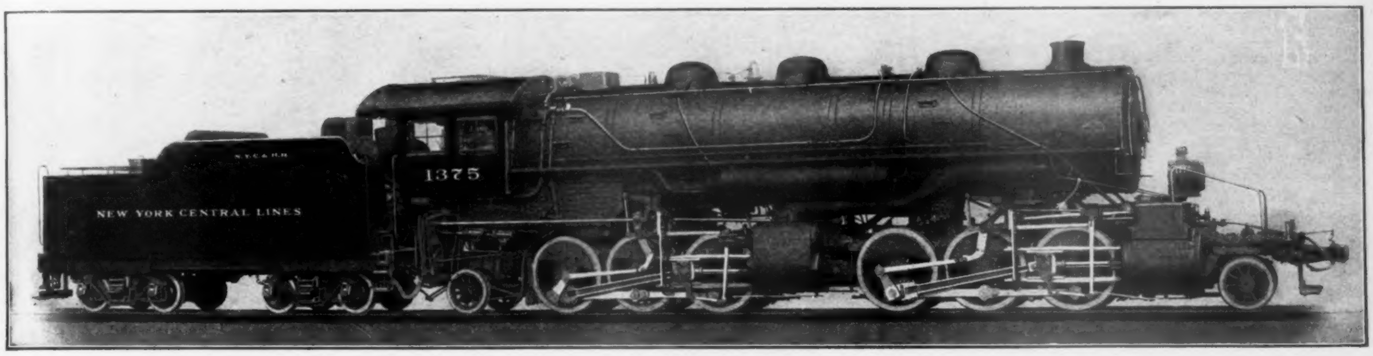
These tests indicated that the Mallet would give considerable economy in fuel per unit of work as compared with the consolidation when operating under the conditions for which it was originally designed, viz., low speed, heavy freight work. The conditions on the Pennsylvania division, however, demanded higher speeds and the testing committee recommended the application of a superheater. The locomotive was then returned to the Schenectady plant of the American Locomotive Company, and equipped with a Schmidt superheater and "Security" brick arch, and some minor changes were made as the tests had shown advisable. It was then returned to the company and the second series of tests were carried out and upon their completion the committee consisting of representatives of the Pennsylvania Railroad, the American Locomotive Company, and the New York Central and Hudson River Railroad, made a report in which appeared the following conclusions upon the advantages of the type:

"Economy in train operation due to larger output in ton-miles per locomotive."

"Greater economy in coal per unit of power due to the larger boiler available and especially to the use of compound cylinders and superheated steam."

"Judging from the construction of the parts of this locomotive and its riding qualities, with the ability to take curvatures as represented on the dvision over which the tests were made, there would seem to be no reason to expect any undue injury to the locomotive itself when running at a speed of 30 miles per hour."

"As to the injury to the track at speeds of 30 miles per hour, the weight per axle for the Mallet is very much below that which is the common practice for passenger engines, where as high as 60,000 lbs. per axle is often employed, and from this standpoint it is considered that no undue injury would be occasioned to a track suitable for consolidation locomotive similar to the G-6-G class."



MALLET LOCOMOTIVE WITH SUPERHEATER IN SERVICE ON THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL.

The result of these tests led the New York Central to purchase 25 more of the same type which are now in service. These were built to practically the same specifications as the one tested except that both the high and low pressure cylinders were increased by about 1 inch and the boiler pressure was reduced by 10 lbs. The general dimensions of the locomotives finally ordered, as well as the one tested and the New York Central G-6-G consolidation and the Pennsylvania H-8-B consolidation locomotive, which were tested in comparison, are given in the accompanying Table 1.

At present the 26 Mallet locomotives are handling the traffic on this division which previously required 60 consolidations. A single Mallet hauls a 4,000-ton train over the division without assistance where previously the maximum tonnage was 3,500 tons which required pusher assistance on the heavier grades. With this increased load the trains daily over the division have been decreased by ten and the overtime has been reduced 80 per cent. It has been found that the Mallet saves on an average of 35 per cent. in fuel per ton-mile. This stated in another way means that 54 per cent. more ton-miles per ton of coal are obtained by the Mallet than by the consolidations which they replaced. The operating capacity of the division has been increased over 40 per cent., *i. e.,* that while formerly 1,000 cars daily was the maximum, 1,400 cars can now be handled in 24 hours.

Altogether the tests extended over a period of 2½ months and every possible refinement leading to accuracy was used. The dynamometer car of the Pennsylvania Railroad* was used and the trains provided were carefully arranged to suit the conditions desired. The tests were made over a portion of the road from Avis Yard, Jersey Shore, to Stokesdale Jct., Pa., a distance of 63.07 miles. It will be seen by the profile that this is on a continuous up-grade and all runs were confined exclusively to the north-bound movement, the engines being turned at Stokesdale and returned light to Avis. The observations were begun at Toburt, 9.67 miles north of Avis, giving this time for getting

* For full illustrated description, see AMERICAN ENGINEER, April, 1910, p. 135.

*See AMERICAN ENGINEER, August, 1907, p. 293.

the locomotive in condition and the fire built up before taking observations. The remaining distance has in it 1.16 miles of descending grade occurring at two points and 4.5 miles of level track distributed over six places.

The two consolidation locomotives were so similar that for

TABLE 1.—GENERAL DIMENSIONS OF LOCOMOTIVES TESTED.

	N. Y. C. Consolidation. Class G.6.G.	P. R. R. Consolidation. Class H.8.B.	Mallet as Modified in Second Test.	Mallet as Finally Ordered.
Maximum tractive effort, lbs....	45,700*	45,300*	66,600	67,500
Maximum tractive effort (working simple) lbs.	......	......	79,900	81,000
Wt. on driving wheels, lbs......	211,000	211,700	304,500	301,500
Wt. on leading truck, lbs........	25,000	26,900	25,000	26,000
Wt. on trailing truck, lbs.......	......	......	22,500	26,500
Wt., total of engine, lbs.........	236,000	238,600	352,000	354,000
Wt. of tender, lbs..............	147,400	158,000	152,700	153,700
Wt., total of engine and tender, lbs.	383,400	396,600	504,700	507,700
Wheel base, rigid, ft. and in....	17- 6	17- ½	10-0	10-0
Wheel base, driving, ft. and in..	17- 6	17- ½	30-8½	30-8½
Wheel base, total of engine, ft. and in.	26- 5	25-9½	46-4	46-9
Wheel base, total of engine and tender, ft. and in.............	60-11½	59-5⅝	74-8	75-8
Cylinders, diameter, in..........	23	24	20½ & 33	21½ & 34
Cylinders, stroke, in............	32	28	32	32
Wheels, diameter of driving, in..	63	62	57	57
Wheels, diameter of truck, in....	33	33	33	33
Wheels, diameter of trailing, in..	..	..	33	33
Wheels, diameter of tender, in..	33	36	33	33
Boiler pressure, lbs. per sq. in...	200	205	210	200
Boiler, type	St. top	Belpaire	St. top	St. top
Boiler, outside diameter, in.....	82	80	83¾	83¾
Firebox, length, in..............	108⅛	110¼	108⅛	108⅛
Firebox, width, in..............	75¼	72	75¼	75¼
Tubes, number	446	465	235—2¼ 36—5½	235—2¼ 36—5½
Tubes, diameter, in.............	2	2	2¼ & 5½	2¼ & 5½
Tubes, length, ft. and in........	15-½	15.0	22.0	22
Heating surface, tubes, sq. ft....	3,512	3,665.91	4,168	4,168
Heating surface, firebox, sq. ft...	184	181.0	185	197.9
Heating surface, water tubes, sq. ft.	27	..	13	27.1
Heating surface, total, sq. ft....	3,702	3,846.91	4,366	4,393
Superheating surface, sq. ft.....	...	...	966.3	966.3
Grate area, sq. ft..............	56.5	55.05	56.5	56.5
Tender, water capacity, gals....	7,500	7,000	8,000	8,000
Tender, coal capacity, tons.......	12	17½	12	12

*Calculated on the basis of a mean effective pressure of 85 per cent. of the boiler pressure.

the purposes of comparison, the average results obtained are given in the accompanying tables.

Coal of excellent and uniform quality was used, a greater proportion of it coming from the same mines. The average of the samples analyzed is given at the top of the next column.

In Table 2 are given general results obtained from the tests. It will be seen that comparative figures are obtained at two different speeds, and that results of the Mallet at 17½ miles

ANALYSIS OF COAL.

Volatile matter..	25.26%
Fixed carbon..	64.28%
Ash	10.44%
Moisture	3.44%
Sulphur	1.92%
B.t.u. (dry coal)..	13,800

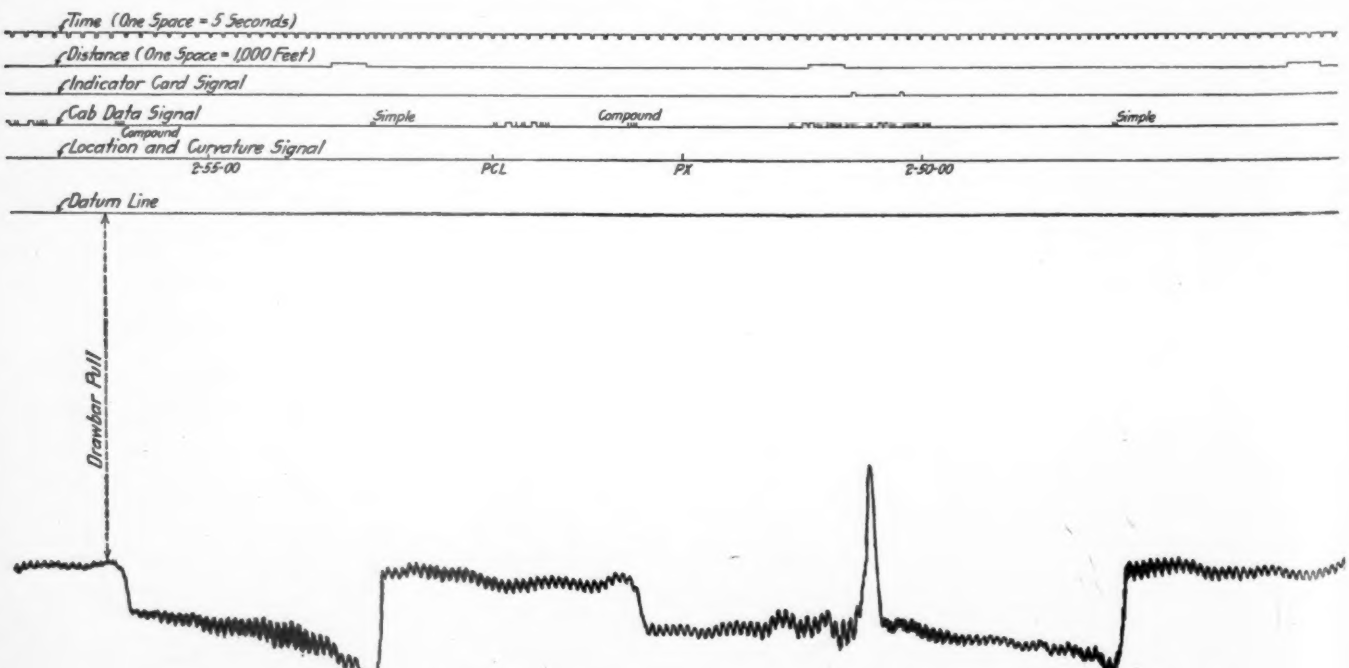
per hour and of the consolidation at 21 miles per hour are also given.

The most important feature shown in this table is given in connection with the amount of coal burned per ton-mile where an economy of 36.6 per cent. in favor of the Mallet is shown. This feature is more strikingly brought out by the comparison shown in Table 3, where the ton-miles per ton of coal in each case are

TABLE 2.—COMPARISON OF GENERAL PERFORMANCE OF MALLET AND CONSOLIDATION LOCOMOTIVES UNDER DIFFERENT SPEED CONDITIONS.

	Approximate average speeds.	Type of Locomotive. 2-8-0	2-6-6-2	Per cent. in favor of Mallet as compared with consolidations,
Number of cars............	12.5	41.5	65.3	57.3
	15.0	36.7	58.2	58.6
	17.5	....	40.	....
	21.0	25.5	....	....
Average weight per car, tons	12.5	60.15	57.2	....
	15.0	55.12	59.5	....
	17.5	.....	64.7	....
	21.0	60.47	....	....
Total tonnage behind tender.	12.5	2,495.5	3,734	49.6
	15.0	2,017.5	3,461	71.5*
	17.5	....	2,588	....
	21.0	1,542	.....	....
Total elapsed time, hours....	12.5	5.89	6.86	....
	15.0	4.65	5.00	....
	17.5	3.51	4.51	....
	21.0	....	....	....
Running time, hours........	12.5	4.605	4.58	....
	15.0	3.765	3.87	....
	17.5	.....	3.37	....
	21.0	2.82	....	....
Average speed, running time, m.p.h.	12.5	12.75	12.9	....
	15.0	15.7	15.2	....
	17.5	....	17.5	....
	21.0	21.4	....	....
Coal per ton-mile, lbs.......	12.5	0.1275	0.077	39.6
	15.0	0.1392	0.084	39.6
	17.5	......	.....	....
	21.0	0.1418	0.086	....

*This relatively higher percentage in favor of the Mallet is probably due to the fact that the consolidations were not loaded to their full capacity at 15 miles per hour.



PORTION OF THE DYNAMOMETER CHART, SHOWING THE EFFECT AND VALUE OF THE SIMPLIFYING FEATURE.

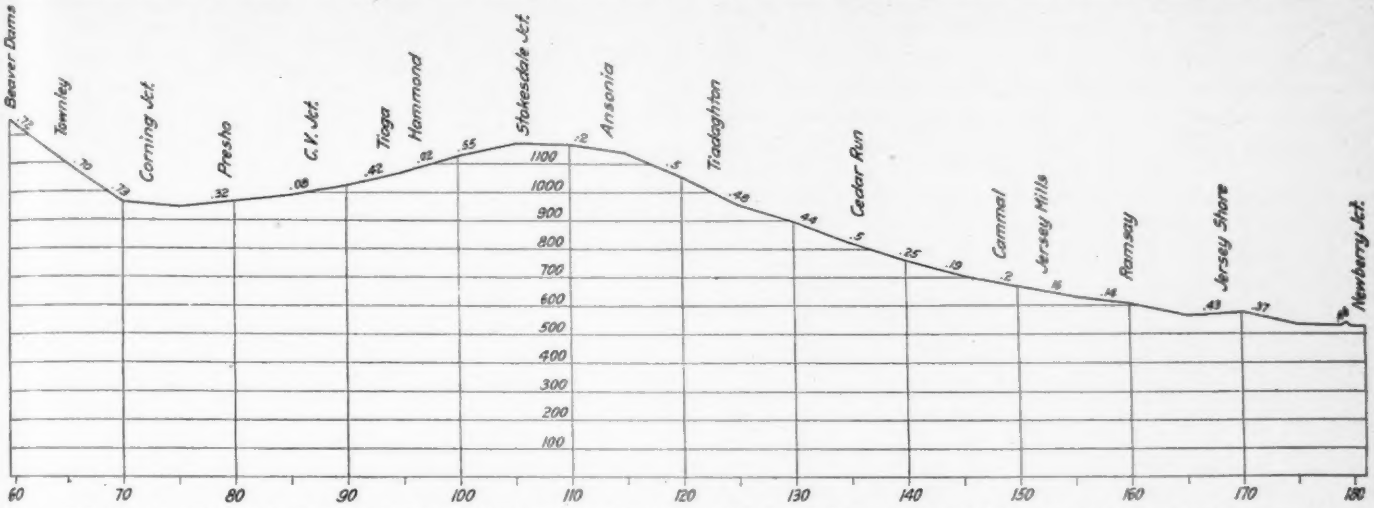
[One quarter inch drawbar pull is equivalent to 7,850 pounds.]

given, showing the minimum of 61.2 per cent. advantage of the Mallet over the average of the two consolidations.

Another interesting fact shown in Table 2 is that within the range of speeds in which it is operated in actual service, the increase in the normal theoretical maximum tractive effort of the Mallet as compared with the simple is fully realized. With the theoretical tractive effort 45 and 47 per cent. greater than the two consolidations tested, the Mallet hauled approximately 49 per cent. more tonnage than the average of the two at speeds of 12½ miles per hour. On these runs both the consolidations were loaded to their full capacity. At speeds of 15 miles per hour it is believed that the consolidations did not have the maximum tonnage that they could haul and it is probable that the tonnage of 12½ miles per hour is a more accurate measure of the capacity.

In order to determine exactly the advantage of the system of compounding used, one run was made with the maximum train load which the Mallet would haul over the division without stalling, the train consisting of 63 steel cars and a caboose, making a total weight of 4,465 tons behind the tender. This run clearly demonstrated the great advantage of the reserve capacity available with this system of compounding which makes it possible to secure 20 per cent. increase of power by the use of the steam direct from the boiler in both the high and low pressure cylinders by virtue of its distinctive features—the separate exhaust from the high pressure cylinders and the intercepting valve.

By means of these special devices, the back pressure on the high pressure cylinders is reduced when working simple and increased power is secured without sacrificing the equal distribution of the work between the two engines.



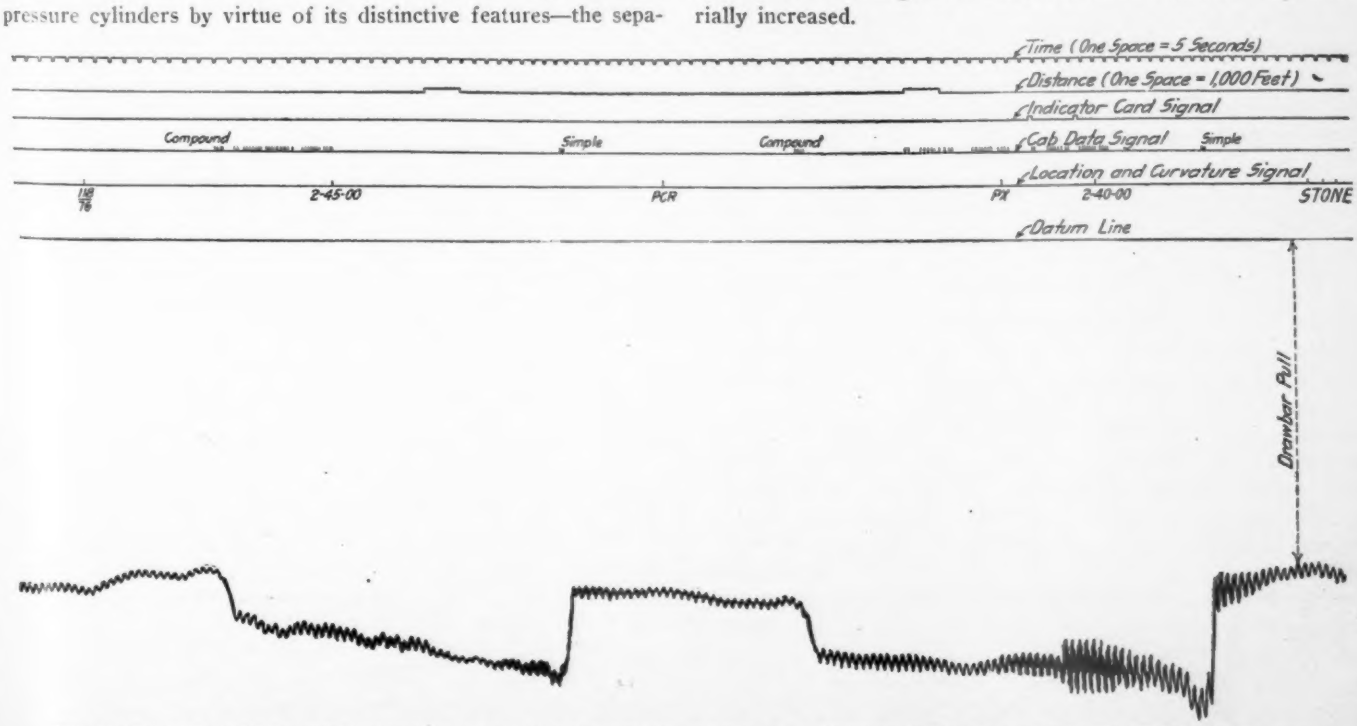
PROFILE OF THAT PART OF THE PENNSYLVANIA DIVISION OF THE NEW YORK CENTRAL ON WHICH THE MALLET LOCOMOTIVES WERE TESTED.

With this reserve power in use at several points, an otherwise prohibitive train load was taken over the division without stalling. During the run the locomotive was simpled approximately 8 per cent. of the time the throttle was open and an average speed of 10.6 miles per hour was made.

TABLE 3.—COMPARATIVE PERFORMANCE IN TON-MILES PER TON OF COAL OF MALLET AND CONSOLIDATION LOCOMOTIVES.

Approximate average speeds.	Ton-Miles Per Ton of Coal. 2-8-0 Type.	2-6-6-2 Type.	Per cent. in favor of Mallet as compared with consolidations.
12.5	16,219.5	26,610	63.9
15.0	14,807.5	23,872	61.2
17.5	....	23,148	....
21.0	14,898	......	....

This run made clear the advantages of this system of compounding for use on divisions which have short grades not sufficient in importance to warrant pusher service, but which nevertheless reduces the train tonnage considerably. Having 20 per cent. increase in power available for short distances, it is evident that the tonnage over such a division could be very materially increased.



THE TRAIN WAS MOVING FROM RIGHT TO LEFT ON THIS CHART WHICH IS A CONTINUATION OF THE ONE ON THE OPPOSITE PAGE.
[*One-quarter inch drawbar pull is equivalent to 7,850 pounds.*]

Table 4 gives a comparison of the boiler performance of the locomotive and emphasizes clearly the advantage in fuel economy of a large boiler with ample margin of capacity above the average demands. Probably the most striking results shown in this table is the increase in equivalent evaporation per pound of dry coal, which at 12½ miles per hour is 18.8 per cent., reaching a figure slightly above 10 lbs. The cause of this is shown in the next column giving the equivalent evaporation per sq. ft. of heating surface, where it will be seen the consolidation boiler is necessarily forced much higher. In the column giving the temperature in the smoke box, the effect of the combustion chamber and longer flues is clearly evident, there being practically 100 degrees difference, although at 12½ miles per hour the fire box temperature is greater in the consolidation.

The thermal efficiency of the boiler in per cent. tells the story and shows an increase of 17.7 per cent. at 12½ miles per hour; this, of course, is only for the conditions holding during the test where it appears that the consolidation boilers were forced beyond their economical limit although not beyond their capacity, while the Mallet boiler, because of its larger size, superheater and brick arch, was being operated well within its capacity. It is to be noted, however, that the relation of the most economical point of a boiler equipped with a superheater much more nearly coincides with its point of maximum capacity than in the case of the saturated steam boiler. The harder a boiler is forced the more economy the superheater will show.

Table 4.—Comparison of Boiler Performance of Mallet and Consolidation Locomotives.

	Approximate average speeds.	Type of Locomotive. 2-8-0	2-6-6-2	Per cent. in favor of Mallet as compared with consolidations.
Dry coal fired per hour	12.5	4,033.5	3,680	....
	15.0	4,420.5	4,423	....
	17.5	....	3,985	....
	21.0	4,957	.....	....
Equivalent evaporation per hour, lbs.	12.5	33,957.5	36,849	8.5
	15.0	36,807.	41,819	13.6
	17.5	....	36,203	....
	21.0	39,859.5	.....	....
Equivalent evaporation per pound dry coal	12.5	8.42	10.01	18.8
	15.0	8.32	9.45	13.58
	17.5	....	9.08	....
	21.0	8.04	....	....
Equivalent evaporation per hour per sq. ft. of heating surface, lbs.	12.5	10.15	9.32	....
	15.0	11.008	10.58	....
	17.5	......	9.16	....
	21.0	11.914	....	....
Coal fired per sq. ft. grate per hour for time throttle was open	12.5	72.34	65.13	....
	15.0	79.26	78.28	....
	17.5	.....	70.54	....
	21.0	88.91	.....	....
Boiler horsepower	12.5	984.25	1,069.1	8.6
	15.0	1,066.9	1,212.1	13.6
	17.5	....	1,049.4	....
	21.0	1,155.35	....	....
Temperature in smokebox	12.5	616.	519.	....
	15.0	633.	522.9	....
	17.5	....	495.2	....
	21.0	633.5	.....	....
Temperature in firebox	12.5	1,805.5	1,742	....
	15.0	1,783.5	1,936	....
	17.5	....	1,785	....
	21.0	1,868	.....	....
Thermal efficiency of boiler, per cent.	12.5	58.68	69.07	17.7
	15.0	58.63	66.62	13.62
	17.5	.....	68.60	....
	21.0	57.51	.....	....

In Table 5 one of the most striking features is the increased machine efficiency shown by the Mallet. The figures were afterwards verified by a test wherein both locomotives were hauled by an electric locomotive, and the only explanation offered is that this is due to the reduction of the unit weight of the moving parts and the shorter rigid wheel base. In this table it will be noted that the column giving the dry coal per dynamometer horse-power per hour shows an economy of 34.4 per cent. minimum and 39.8 per cent. maximum. This result is, of course, the true measure of the economy in coal consumption of two locomotives since all local conditions such as profile and variations in train loading are eliminated.

It appears that the economy of water is not so great as of coal. This would be expected from the evaporation figures given in Table 4. The thermal efficiency of the locomotive is very good in the case of the Mallet, reaching 5.59 per cent. maximum and in all cases being above 5 per cent.

Taken altogether these tests are most encouraging for the success of the Mallet locomotive under conditions for which it is suitable and especially in connection with its use at the higher speeds. It is unfortunate that the data obtained from the tests made on the original locomotive before it was equipped with superheater and brick arch are not available for publication, as it makes it impossible to determine exactly how much of the success of the locomotive as a whole can be assigned to the superheater.

Table 5.—Comparison of Performance as a Whole of Mallet and Consolidation Locomotives.

	Approximate average speeds.	Type of Locomotive. 2-8-0	2-6-6-2	Per cent. in favor of Mallet as compared with consolidations.
Average speed running time, miles per hour	12.5	12.75	12.9	....
	15.0	15.7	15.2	....
	17.5	....	17.5	....
	21.0	21.4	....	....
Average drawbar pull, lbs.	12.5	22,726	34,071	49.9
	15.0	19,883	31,360	56.9
	17.5	......	23,424	....
	21.0	15,930	......	....
Maximum starting drawbar pull, lbs.	....	46,280	66,000 working compound	42.6
			80,000 working simple	72.8
Machine efficiency, per cent.	12.5	88.85	89.21	....
	15.0	86.17	89.16	....
	17.5	.....	86.60	....
	21.0	85.35	.....	....
Machine friction in lbs. of drawbar pull	12.5	3,066.5	4,468	....
	15.0	3,517.	4,083	....
	17.5	......	4,044	....
	21.0	3,288.5	.....	....
Dry coal per dynamometer horsepower per hour, lbs.	12.5	5.235	3.15	39.8
	15.0	5.295	3.47	34.4
	17.5	.....	3.65	....
	21.0	5.465	....	....
Water per dynamometer horsepower, lbs.	12.5	33.465	26.80	22.9
	15.0	33.56	26.83	20.05
	17.5	.....	27.08	....
	21.0	33.685	.....	....
Thermal efficiency of locomotive, per cent.	12.5	3.50	5.59	59.7
	15.0	3.50	5.32	52.0
	17.5	....	5.43	....
	21.0	3.445	....	....

SAFETY PLAN ON THE BALTIMORE AND OHIO

With a view to promoting safety of travel and protecting its employees from personal injury in the discharge of duty, the Baltimore and Ohio has appointed a safety committee to pursue the matter vigorously through a campaign which is to extend to all branches of the service and over every mile of track operated in the system. The safety committee, which began work November 1st with General Manager Thompson as chairman ex-officio, is composed of general officers of the road. Divisional safety committees have also been appointed, composed of division officials, secretaries of the Railroad Young Men's Christian Association, an employee from each shop to represent shopmen, an engineer to represent enginemen, conductor to represent trainmen and yardmaster to represent yard employees.

Several months ago the Baltimore and Ohio management adopted a number of precautionary measures in its locomotive and repair shops for the protection of its workmen, equipped machinery with guard-rails and covers for exposed parts, and the latest steps for safety is an effort to extend this to all branches of the service.

The Great Corliss Engine, the power feature at the Centennial Exposition in Philadelphia in 1876, afterward removed to the Pullman Company's plant at Pullman, Ill., was sold October 5 to the Oakdale Iron Company, Chicago, for scrap. This engine, although rated at only 1,400 h.p., weighed over 650 tons

MOTOR DRIVE FOR PLANERS

At a recent meeting of the Association of Iron and Steel Electrical Engineers in New York, G. W. Richardson, electrical superintendent, American Bridge Company, Philadelphia, read a paper on motor drives for planers in which he said in part:

A motor to drive a planer reversing with every stroke, from the shortest to the full stroke of the planer table, must be a very slow-speed motor, controlled by automatic controller and requiring dynamic braking to stop the table so that there will not be any counter-electromotive force at the time the applied electromotive force is applied to the armature of the motor at the moment of reversals. This must be so arranged that the dynamic braking relay is off at the moment the applied electromotive force is connected and that the dynamic braking take effect at the moment the applied electromotive force is opened. This is really the success of the direct-connected reversing motor drive to-day on planers.

In our machine-shop we have a 120-in. planer which was driven by a 45-h.p. compound wound constant-speed motor driving through a countershaft to the belt shaft containing the flywheel and belt pulleys. These belts were vertical, and 6 in. wide and 4-ply. They reversed from one pulley to the other in the usual way. At the moment of these reversals the motor would be extremely overloaded. These high peaks of current continually coming on the motor at every reversal caused trouble, and we were always doing some repairs. Over 2 galls. of oil were used per day on the planer. The actual delays to the work due to the conditions probably amounted to at least 25 to 30 per cent. of the time of cutting material.

I was asked to try one of my double-armature motors to see if we could overcome the difficulties we were having with the old drive. I installed one 50-h.p., 220-volt, compound wound double-armature motor on the 120-in. planer on December 1st, 1909, using an automatic controller from one of our mill tables, with the exception that I added some new features, such as dynamic braking, field weakening relays, and no-voltage and overload relays. This outfit has not given us any trouble whatever, except the first few days in getting the controller adjusted. The apparatus uses approximately one pint of oil per day. The planer does not chatter. The full speed of the double-armature motor while cutting is 224 revs. per minute, and the center shaft speed is 128 revs. per minute. The peak load is 100 amperes, approximately 30 h.p., starting torque. The dynamic braking current is approximately 150 amperes. The periphery speed of the armatures while cutting is 896 ft. per minute, and 1,792 ft. per minute on the return stroke of the table. This makes the motor easy to reverse, due to the low centrifugal force of the armatures. The cutting speed is from 20 ft. to 25 ft. per minute, and the return speed is from 20 ft. to 50 ft. per minute.

A reversing motor drive that has been placed on Pond planers is no doubt a good apparatus for this kind of work. They use

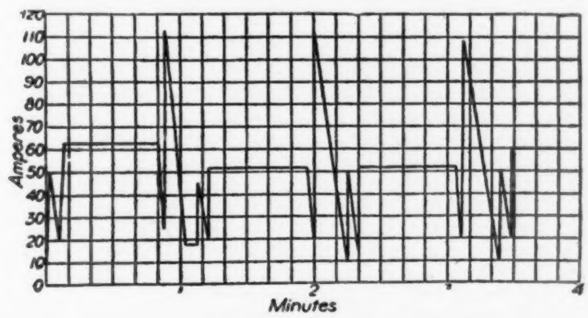


FIG. 1.—CURRENT DEMAND WITH 50-H.P. REVERSING MOTOR ON 8-FT. PLANER.

a single-armature special-made interpole motor, wound 1 to 4 speed, that is, 250 to 1,000 revs. per minute, using dynamic braking for stopping the motor before reversing. The periphery speed of the armature of a 50-h.p. motor for a 96-in. planer is approximately 1,177 ft. per minute to 4,710 ft. per minute. The cutting peak load is 50 amperes, while the reversing peak load is 112 amperes. The cutting speed 12 ft. to 25 ft. per minute, and the reversing speed 12 ft. to 48 ft. per minute.

The curve, Fig. 1, shows the ampere load on the 50-h.p. Niles-Bement-Pond Company's reversing motor drive on a 96-in. planer, cutting speed 12½ ft. per minute, return speed 42 ft. per minute, one tool cutting ⅝ in. with ⅛-in. feed, cutting annealed nickel-chrome steel. This curve shows the peak load to start motor was 50 amperes, then, as the speed increased, the time of start to the time of cut was 5 secs. and the current dropped to 20 amperes. Then, as the tool cut into the material the current went up to 62 amperes for 43 secs., then the current was off for 2½ secs. Then, reversing to high speed, the current rose to 112 amperes and the speed kept getting faster until the current was down to 18 amperes, taking about 10 sec. time, then the line continued straight for 5 secs., which was the full return stroke. Then the peak from return to cut rose to 45 amperes and dropped down to 20 amperes for 5 secs. before the tool started the second cut, then the current rose to 51 amperes. The other cuts and reversals were practically the same, except the curve shows that the motor kept getting faster on the return stroke and the current made a practically straight line for 15 secs., the full return stroke. The full field of the motor was approximately 10 amperes.

The curve, Fig. 2, shows our 15-h.p. motor driving a 42-in. Pond planer. This is a two-armature motor, capacity 60 am-

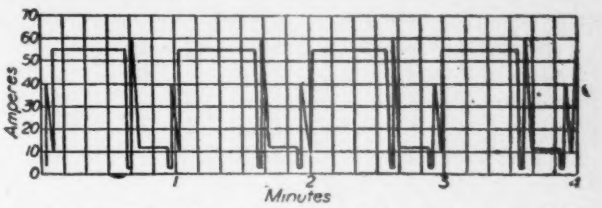


FIG. 2.—CURRENT DEMAND WITH 15-H.P. RICHARDSON MOTOR ON 42-IN. PLANER.

peres. This curve shows that at the time this test was taken the cutting speed was 17 ft. per minute, return speed 44 ft. per minute. Two tools were used, each taking a ½-in. cut and a 3/32-in. feed, cutting cast steel. The shunt field of this motor took 3 amperes. To start required a peak load of 40 amperes, then, as the speed increased, the current dropped to 10 amperes in 3½ secs. before the tool started to cut, then the current rose to 55 amperes for 33 secs.; then the current was off for 1½ secs. when the return peak rose to 60 amperes and the motor got to full speed in 2½ secs. Then the current dropped to 12 amperes for 13½ secs., then the current was off, and so on. This curve shows that the double-armature motor drive gets up to speed quickly with peak loads only to the capacity of the motor. Therefore, the motors run cool and without trouble.

A TRAIN LIGHTING INSTRUCTION CAR

The Pennsylvania Railroad Company has added an unique instruction car to the list of such which various railroads operate for the benefit of their employees, and which is intended to exemplify the various details connected with train lighting. It is a singular fact that although instruction in air brake, through practical demonstration; in combustion and good firing, etc., through lectures, has been widely diffused, the train lighting problem has been practically neglected previous to this innovation.

The Pennsylvania Railroad has at this time no less than eight distinct axle device systems, in addition to the large number of straight storage equipments, and the new car seems to offer the most efficient means of furnishing uniform instructions to yard electricians.

The apparatus installed consists of a 32-cell storage battery; a 15 kw. Curtis turbo-generator; a variable speed motor, with necessary controlling apparatus for driving the axle devices, and the following axle generators with their regulating equipments: Newbold, Moskowitz, Bliss, Consolidated, Safety and Gould. The present intention is that the car will be sent to the different points at which electrical forces are maintained, and the men at such points will be given lectures and demonstrations on the operation and maintenance of these various systems.

With the instruction car in operation it is intended that all employees whose duties have to do with the car lighting shall be instructed in the care and operation of the various equipments, with the two-fold object of educating those interested and securing uniformity in their work.

THE MORE ALUMINIUM an aluminium bronze contains, the softer it is while hot. This is the reverse of hardness of the cold bronzes. While a 10 per cent. aluminium bronze is much harder than a 4 per cent. bronze while cold, it is very much softer while hot, and can be rolled hot much easier.

NEW MIKADO TYPE LOCOMOTIVES

SOUTHERN RAILWAY CO.

With constantly increasing traffic requirements it has been found necessary to introduce heavier power into the freight service of the Southern Railway. Heretofore the heavy freight traffic on this road has been handled by engines of the consolidation, or by those of the ten-wheel type, with the former predominating. The largest of the former, as built by the Baldwin Locomotive Works, have cylinders 22 by 30 in., and 57 inch driving wheels. Saturated steam at 200 pounds pressure is employed, and the total weight is 210,000 lbs., with 188,000 lbs. on driving wheels.

These engines, numbered in "600," first appeared on the road in 1904 and were well distributed over the system, but particularly on the Knoxville division where they did very good work and fulfilled every requirement up to a comparatively recent period.

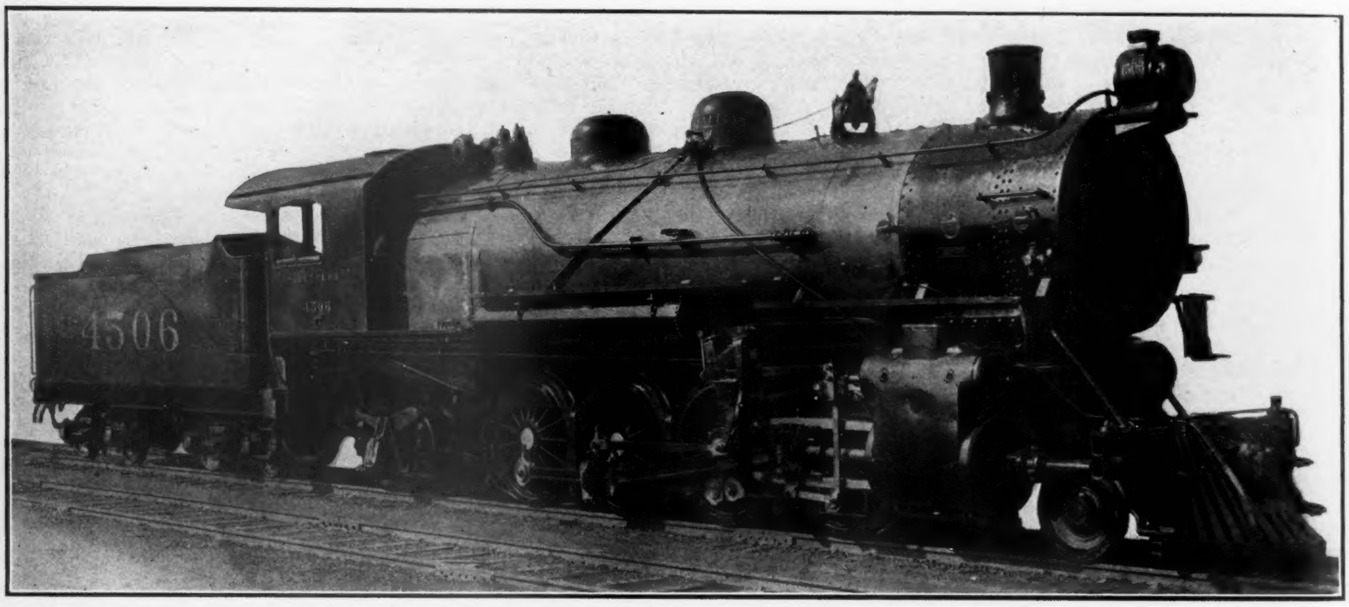
The determination of the management to go into the Mikado type, at least in part, is merely in accord with the popularity which this design now enjoys among a large number of prominent railroads, wheron, in several instances, it has attained supremacy over the consolidation, for the reason, principally, which is well understood, that of increased boiler capacity coupled with the ability to increase the average speed of heavy trains.

The new Mikados which have been recently delivered by the Baldwin Locomotive Works to the Southern are a fine example of this type. Thirty-three locomotives were included in the contract, and they have approximately 20 per cent. greater hauling capacity than the consolidations before mentioned. They exert a tractive effort of 51,700 lbs., and with 215,700 lbs. on the driving wheels, the ratio of adhesion is 4.17. These locomotives use highly superheated steam at a pressure of 175 lbs., the superheater being of the Schmidt top header, fire-tube type, with 30 elements, each consisting of a double loop of pipes 1 7/16 in. in diameter.

The boiler used in this design has a long tapered ring in the middle of the barrel, the diameter being 76 inches at the front end and 83 inches at the dome ring. The dome is of pressed steel, ¾ in. thick, and the longitudinal seam on the dome ring is welded throughout its length, on either side of the dome opening. The firebox is built with vertical side water legs, and the staybolts include 674 of the flexible type. These latter stay the entire throat sheet, and are used in the three outside rows in the back head. In the sides they are located in the six upper horizontal rows, and in the four vertical rows at each end. The grate is practically the same size as that used on the consolidation engines, and in this connection the point has not been lost sight of to retain the interchangeability of many castings. The ash pan is constructed with a continuous slope front to back, and has a damper at the back end, through which the ashes can be discharged by a blower located in the front end of the pan.

The frames are of the most substantial design and construction, both main and rear sections being vanadium steel castings of ample section. The main frames are 5 in. wide, and have a depth of 6½ in. over the pedestals, while the rear sections are 4½ in. wide. Each main frame is in one piece with a single front rail, which has a depth of 13 in. under the cylinder saddle. The pedestal binder bolts are inserted from below, and each bolt has a shoulder which fits into a counterbore in the lower frame rail. The bolt has a taper fit in the frame and a straight fit in the pedestal binder. A single nut is used on the top and two nuts with a cotter on the bottom.

The transverse frame braces include deep steel castings at the second and third pairs of driving pedestals. A similar casting is placed under the front end of the firebox, immediately ahead of the splice between the main and rear frames. The bottom frame rails are braced just back of the first driving pedestals; while the guide yoke, which is of cast steel, constitutes a strong transverse brace, with bearings 24¼ in. long on each frame. The rear bumper consists of two 10 in. channels placed back to back. The spring rigging calls for no special comment, other than the novelty of the equalizer of the trailer being guided in a pedestal in the rear frame section. The trailer is of the Hodges type, which has been extensively used on rear truck locomotives built at the Baldwin Works.



MIKADO TYPE LOCOMOTIVE WITH SUPERHEATER.

The steam distribution is controlled by 14 in. piston valves, driven by the Walschaert motion. In the present case the link and reverse shaft bearings are supported on the guide yoke; and the reverse shaft has a downwardly extended arm, to which the reach rod is attached. Extension rods are used on the valves and pistons.

The tender is built in accordance with Southern Ry. practice, and has a frame composed of 12 in. steel channels with oak bumpers. The tank carries 8,000 gallons of water and 14 tons of coal. Similar locomotives are being built for the Mobile and Ohio, the Virginia & Southwestern, and the Cincinnati, New Orleans & Texas Pacific railways.

The principal dimensions are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	51,700 lbs.
Weight in working order	272,940 lbs.
Weight on drivers	215,700 lbs.
Weight on leading truck	22,860 lbs.
Weight on trailing truck	34,380 lbs.
Weight of engine and tender in working order	420,000 lbs.
Wheel base, driving	16 ft. 6 in.

Wheel base, total	34 ft. 9 in.
Wheel base, engine and tender	67 ft. ¾ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.17
Total weight ÷ tractive effort	5.08
Tractive effort × diam. drivers ÷ heating surface*	730.00
Total heating surface* ÷ grate area	83.54
Firebox heating surface ÷ total heating surface* per cent	4.5
Weight on drivers ÷ total heating surface*	4.82
Total weight ÷ total heating surface*	61.29
CYLINDERS.	
Kind	Simple
Diameter and stroke	27 x 30 in.
VALVES.	
Kind	Balanced piston
Diameter	14 in.
WHEELS.	
Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	42 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Wagon top
Working pressure	175 lbs.
Outside diameter of first ring	76 in.
Firebox, length and width	107⅛ x 71¾ in.
Firebox plates, thickness	S. ⅜ in., B. ⅜ in., C. ⅜ in., T. ½ in.
Firebox water space	F. S. & B. 5 in.
Tubes, number and outside diameter	30—5½, 183—2¼ in.
Tubes, length	20 ft.
Heating surface, tubes	3,007 sq. ft.
Heating surface, firebox	191 sq. ft.
Heating surface, total	3,198 sq. ft.
Superheater heating surface	837 sq. ft.
Grate area	53.3 sq. ft.
TENDER.	
Frame	Steel channels
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	14 tons

* Equivalent heating surface = 4,454 sq. ft.

MAINTENANCE AND OPERATION OF LOCOMOTIVE SUPERHEATER

The Locomotive Superheater Company* has compiled some very interesting information concerning the care and operation of the Schmidt superheater which is considered of sufficient practical value to abstract as follows:

The front end should be carefully inspected every month and the deflecting plate in front of superheater is to be removed for this purpose. The inspection should cover examination for air and steam leaks in front end, for any accumulation of cinders and ashes or deposits on return bends in boiler flues. All air and steam leaks should be stopped. In the case of steam leaks between the header and the superheater units, joints should be immediately tightened, if necessary regrinding ball joints or applying a new gasket to flat joints. When a gasket is applied the joint should be tightened again after the gasket has been under steam pressure the first time.

For the flat joint gaskets we recommend the metal-asbestos gaskets of the Goetze-Gasket and Packing Company, of New Brunswick, N. J. This gasket should be kept in stock where used.

The flues can be easily inspected from the front while a light is held at the firebox end. At regular intervals the boiler flues should be blown out, the same as the boiler tubes are blown out, and thoroughly cleaned of all ashes, cinders and soot. At the same time any deposit which may have accumulated on the return bends nearest the firebox should be broken off and removed. For cleaning the flues the use of air of at least 100 lbs. pressure is recommended in preference to steam or water. It should be applied through a one-half inch gas pipe, which is inserted at the back end of the flue and gradually worked forward under the superheater unit, blowing the dirt out of the front end of the flue. In case steam is used instead of air for blowing out the flues the boiler should be under steam pressure to avoid the condensation of water in the flue, as it would be liable to mix with the ashes, etc., and form a coating on the inside of the large flues. The superheater damper should be open in all cases while cleaning flues.

Every two months the superheater and the steam pipes should be tested with warm water of about 100 lbs. pressure to make sure that all joints, etc., are tight in front end. The return bends at firebox ends should be examined from firebox end at this test.

In setting the flues the prosser should be used and the use of the prosser in preference to the roller is recommended whenever possible in working over the boiler flues. The prosser should have not less than twelve sections, and the rollers not less than five rolls. Inserting plugs in the regular tubes surrounding boiler flues when using roller has proved good practice.

The superheater damper and rigging should work freely, and the damper should be wide open when the throttle is open and there is steam in the damper cylinder. With no steam in damper cylinder the damper should be closed.

The safe ending of boiler flues, when such action becomes necessary, should be done at the firebox end of the flue. The diameter of the boiler flue at this point is 4½ in. outside diameter, the flue having been swaged down from its nominal size to this figure. The method of safe ending should be, in general principle, the same as the usual practice for the 2 in. or 2¼ in. boiler flues. The increased diameter and size of the flue will, of course, require larger machinery for performing this operation.

When the engine is in for general repairs the superheater parts should be carefully cleaned, examined and any defective parts repaired or replaced. The ball joints should be reground and joint should show a good continuous bearing all round the ball. With the flat gasket type of joint between header and superheater units the flange on the unit should come up parallel to the face of header so that the gasket has only to make the joint and does not have to take care of any angle between the flange and header. In replacing the superheater units it is essential that they be properly located in the top of the flue to prevent obstruction to the flow of gases through the flue.

In locating the superheater header, its face for superheater unit joints should be square with the tube sheet, parallel to the top row of flues and at the correct distance above them to insure correct position of the superheater unit in the flue. It should be firmly supported at the ends by header supports. These supports should be correctly located, after header has been placed in its proper position, and securely fastened to the shell of the boiler before the superheater units are put in place. The joint between the header and dry pipe should have a loose ball point ring with the flat face on the header in order to permit of free adjustment of the header.

In storing engines equipped with superheaters, especially where liable to freeze, it is essential that the superheater be thoroughly blown out.

* 30 Church Street, New York.

BLACKSMITHS TO MEET IN CHICAGO.—The executive committee of the International Railroad Master Blacksmiths' Association and President Hoeffle of the organization met in Chicago in October and arranged for the next convention place. Chicago was chosen as place of meeting and the Hotel Sherman was selected as the official headquarters. The convention is to be held on the third Tuesday of August, 1912. The new executive committee is as follows: J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman; George Hartline, L. S. & M. S., Collinwood, O.; Wm. Mayer, Michigan Central, Detroit, Mich.; J. S. Sullivan, Pennsylvania Lines, Columbus, O., and W. C. Scofield, Illinois Central, Chicago.

THE WINTER MEETING OF THE ASSOCIATION OF TRANSPORTATION and Car Accounting Officers will be held at the Seelbach Hotel, Louisville, Ky., 10 A. M., December 12-13, 1911. Reports of the following Committees will be considered: Executive Committee, Committee on Car Service, Committee on Office Methods and Accounting, Committee on Handling Railroad Business Mail, Committee on Conducting Freight Transportation, Committee on Conducting Passenger Transportation, Committee on Joint Interchange and Inspection Bureaus.

AT A MEETING OF THE EXECUTIVE COMMITTEE of the Master Boiler Makers' Association, held at the Fort Pitt Hotel in Pittsburgh, Saturday, October 28th, it was unanimously decided to hold the Sixth Annual Convention of this Association in Pittsburgh, May 14th to 17th, inclusive, 1912—headquarters being at the Fort Pitt Hotel. George N. Riley, of the National Tube Company, was made Chairman of the General Committee of Arrangements, and J. Rogers Flannery, of the Flannery Bolt Company, Secretary and Treasurer of such Committee.

THE CUNARD LINER "AQUITANIA" when completed will be 865 feet long, exceeding the present largest steamship, the *Olympic*, by 12 feet 6 inches.